

ADMIN RECORD

**REVISION B - DRAFT
TECHNICAL MEMORANDUM NO. 1**

CORRECTIVE MEASURES STUDY/FEASIBILITY STUDY

Development of Corrective/Remedial Action Objectives

Rocky Flats Environmental Technology Site
Walnut Creek Priority Drainage
(Operable Unit No 6)

EG&G ROCKY FLATS, INC
P O Box 464
Golden, Colorado
80402-0464

Prepared For

UNITED STATES DEPARTMENT OF ENERGY
Rocky Flats Environmental Technology Site
Golden, Colorado

February 1995

DOCUMENT CLASSIFICATION
REVIEW WAIVER PER
CLASSIFICATION OFFICE

**CORRECTIVE MEASURES STUDY/FEASIBILITY STUDY
TECHNICAL MEMORANDUM NO. 1
DEVELOPMENT OF CORRECTIVE/REMEDIAL ACTION OBJECTIVES
FOR OPERABLE UNIT NO. 6
WALNUT CREEK PRIORITY DRAINAGE**

**U.S. Department of Energy
Rocky Flats Environmental Technology Site
Golden, Colorado**

**Draft
Revision B**

February 1995

CMS/FS TECHNICAL MEMORANDUM NO. 1
APPROVAL SHEET

EG&G Rocky Flats, Inc	Document Number	<u>RF/ER-95-0015</u>
	Section	<u>Approval Sheet</u>
	Page	<u>1</u> of <u>1</u>
	Effective Date	<u>February 1995</u>
	Organization	<u>ER OU 5, 6, & 7 Closures</u>

TITLE

Operable Unit No 6, Technical Memorandum No 1
Corrective Measures Study/Feasibility Study
Development of Corrective/Remedial Action Objectives
Rocky Flats Environmental Technology Site
Walnut Creek Priority Drainage

APPROVED BY

OU5, 6, & 7 Closures Program Manager

____/____/____
Date

OU6 Project Manager

____/____/____
Date

ER QA Program Manager

____/____/____
Date

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Table of Contents
Revision B - Draft	Page	1
February, 1995	Organization	ER OU 5, 6, & 7 Closures

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
LIST OF FIGURES	iv
LIST OF TABLES	v
LIST OF ACRONYMS	vi
1.0 INTRODUCTION	
2.0 BACKGROUND	2-1
2 1 Chemicals of Concern	2-1
2 1 1 Human Health Chemicals of Concern	2-4
2 1 2 Environmental Chemicals of Concern	2-4
2 2 Environmental Media Contamination	2-4
2 2 1 Surface Soil	2-7
2 2 2 Subsurface Soil	2-8
2 2 3 Pond and Stream Sediment	2-11
2 2 4 Upper Hydrostratigraphic Unit Groundwater	2-11
2 2 5 Surface Water	2-13
3.0 CORRECTIVE/REMEDIAL ACTION OBJECTIVES FOR OU6	3-1
4.0 REMEDIATION TARGETS FOR OU6	4-1
4 1 Resources for Identifying Potential Remediation Targets	4-1
4 1 1 Chemical-Specific ARARs	4-1
4 1 2 Risk-Based Preliminary Remediation Goals	4-2
4 1 3 Other Readily Available Information	4-5
4 2 Surface Soils	4-6
4 2 1 Background Concentrations	4-8
4 2 2 Potential Chemical-Specific ARARs/TBCs	4-8
4 2 3 Programmatic Risk-Based Preliminary Remediation Goals	4-8
4 2 4 Cleanup Standards at Other Colorado Sites	4-9
4 2 5 Selection of Remediation Targets for Surface Soils	4-9
4 3 Subsurface Soils	4-10
4 3 1 Background Concentrations	4-10
4 3 2 Potential Chemical-Specific ARARs/TBCs	4-12

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Table of Contents
Revision B - Draft	Page	11
February, 1995	Organization	ER OU 5, 6, & 7 Closures

TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
4 3 3 Programmatic Risk-Based Preliminary Remediation Goals	4-12
4 3 4 Cleanup Standards at Other Colorado Sites	4-12
4 3 5 Selection of Remediation Targets for Subsurface Soils	4-13
4 4 Sediments	4-14
4 4 1 Background Concentrations	4-14
4 4 2 Potential Chemical-Specific ARARs/TBCs	4-14
4 4 3 OU-Specific Risk-Based Preliminary Remediation Goals	4-17
4 4 4 Cleanup Standards at Other Colorado Sites	4-18
4 4 5 Selection of Remediation Targets for Sediments	4-18
4 5 Groundwater	4-18
4 5 1 Background Concentrations	4-20
4 5 2 Potential Chemical-Specific ARARs/TBCs	4-20
4 5 3 Risk-Based Programmatic Preliminary Remediation Goals	4-23
4 5 4 Cleanup Standards at Other Colorado Sites	4-23
4 5 5 Selection of Remediation Targets for Groundwater	4-24
4 6 Surface Water	4-25
4 6 1 Background Concentrations	4-25
4 6 2 Potential Chemical-Specific ARARs/TBCs	4-25
4 6 3 Programmatic Risk-Based Preliminary Remediation Goals	4-29
4 6 4 Cleanup Standards at Other Colorado Sites	4-29
4 6 5 Selection of Remediation Targets for Surface Water	4-30
5.0 CMS/FS CONSIDERATIONS	5-1
5 1 CDPHE Conservation Screen Results	5-1
5 2 Remediation Target Screen	5-4
5 3 Conclusions	5-6
5 4 CMS/FS Recommendations	5-8

REFERENCES

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Table of Contents
Revision B - Draft	Page	111
February, 1995	Organization	ER OU 5, 6, & 7 Closures

TABLE OF CONTENTS

(Continued)

<u>Section</u>	<u>Page</u>
----------------	-------------

APPENDICES

Appendix A	OU6 IHSS Descriptions
Appendix B	Reasonable Maximum Exposure and Central Tendency Exposure Factors
Appendix C	Chemical-Specific Toxicity Information for OU6 Chemicals of Concern
Appendix D	Risk-Based Preliminary Remediation Goal Equations for OU6 Sediments
Appendix E	Potential Chemical-Specific ARARs/TBCs
Appendix F	CDPHE Conservative Screen Results
Appendix G	Remediation Target Screen Results

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Table of Contents
Revision B - Draft	Page	iv
February, 1995	Organization	ER OU 5, 6, & 7 Closures

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>
2-1	Location Map
2-2	Location of OU6 IHSSs

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Table of Contents
Revision B - Draft	Page	v
February, 1995	Organization	ER OU 5, 6, & 7 Closures

LIST OF TABLES

<u>Table</u>	<u>Title</u>
2-1	Human Health Chemicals of Concern by Environmental Media
2-2	Environmental Media Sampled During OU6 RFI/RI
2-3	Surface Soil Chemicals of Concern by IHSS
2-4	Subsurface Soil Chemicals of Concern by IHSS
2-5	Sediment Chemicals of Concern by IHSS
2-6	Groundwater Chemicals of Concern by Groundwater Area
2-7	Surface Water Chemicals of Concern by IHSS
4-1	Programmatic Exposure Pathways for Human Health
4-2	Preliminary Remediation Levels for Surface Soil
4-3	Preliminary Remediation Levels for Subsurface Soil
4-4	Preliminary Remediation Levels for Pond Sediment
4-5	Preliminary Remediation Levels for Stream Sediment
4-6	Preliminary Remediation Levels for Groundwater
4-7	Preliminary Remediation Levels for Surface Water
5-1	CDPHE Conservative Screen Summary
5-2	Remediation Target Screen Summary

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Table of Contents
Revision B - Draft	Page	v1
February, 1995	Organization	ER OU 5, 6, & 7 Closures

LIST OF ACRONYMS

AEA	Atomic Energy Act
ARAR	Applicable or Relevant and Appropriate Requirement
BRA	Baseline Risk Assessment
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS/FS	Corrective Measures Study/Feasibility Study
C/RAO	Corrective and/or Remedial Action Objective
COC	Chemical of Concern
CT	Central Tendency
DCG	Derived Concentration Guide
DOE	U S Department of Energy
EPA	U S Environmental Protection Agency
ERA	Ecological Risk Assessment
HHRA	Human Health Risk Assessment
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
LDR	Land Disposal Restriction
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PRG	Preliminary Remediation Goal
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SVOC	Semivolatile Organic Compound
TBC	To-Be-Considered
TSCA	Toxic Substances Control Act
UHSU	Upper Hydrostratigraphic Unit

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Table of Contents
Revision B - Draft	Page	vii
February, 1995	Organization	ER OU 5, 6, & 7 Closures

LIST OF ACRONYM
(Continued)

UTL	/	Upper Tolerance Limit
VOC		Volatile Organic Compound
WQCC		Water Quality Control Commission

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Introduction
Revision B - Draft	Page	1-1
February, 1995	Organization	ER OU 5, 6, & 7 Closures

1.0 INTRODUCTION

Operable Unit No 6 (OU6) is one of several areas at the Rocky Flats Environmental Technology Site (RFETS) which may require remediation in accordance with provisions of the 1991 Interagency Agreement (IAG) between the U S Department of Energy (DOE), the U S Environmental Protection Agency (EPA), and the State of Colorado (State) (IAG, 1991) to ensure protection of human health and the environment. As outlined in Section IX A 1 of the IAG Statement of Work, Corrective/Remedial Action Objectives (C/RAOs) are to be developed to specify the contaminants and media of interest, exposure pathways and receptors, and accepted levels or ranges of levels for each exposure route. This Technical Memorandum is intended to fulfill these requirements for OU6 by establishing C/RAOs that are protective of human health and the environment.

The primary focus of this Technical Memorandum is to present the remediation targets that have been selected to ensure that residual risk to human health and the environment are controlled. The human health chemicals of concern (COCs) for OU6 presented in Technical Memorandum No 4 (DOE, 1994a) were used as the basis for establishing the remediation targets. Several other sources of information and data were considered in establishing remediation targets. These include:

- Background concentrations reported in the *Final Background Geochemical Characterization Report* (DOE, 1993) and surface soil analytical data associated with Resource Conservation and Recovery Act (RCRA) Facility Investigations and Remedial Investigations (RFI/RI) conducted at OU1 and OU2,
- Potential chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) and to-be-considered criteria or guidelines (TBCs),
- Programmatic risk-based preliminary remediation goals (PRGs), and
- Other pertinent information

Remediation targets were identified by environmental media including surface soil, subsurface soil, pond sediment, stream sediment, groundwater, and surface water. COCs for environmental receptors are currently being developed and are not available for the inclusion into this Technical Memorandum. In addition, this Technical Memorandum identifies Individual Hazardous Substance Sites (IHSSs) and media recommended for No Further Action based on a conservative risk-based screen developed by the Colorado Department of Public Health and

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Introduction
Revision B - Draft	Page	1-2
February, 1995	Organization	ER OU 5, 6, & 7 Closures

Environment (CDPHE) and a comparison of the RFI/RI analytical results to the remediation targets

The OU6 remediation targets will form the basis for identifying and evaluating remedial technologies while the Baseline Risk Assessment (BRA), which includes the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA), is being completed. Although there is a certain level of risk associated with developing remedial alternatives prior to fully characterizing the risks associated with OU6, the approach adopted for this Technical Memorandum is consistent with the procedures outlined in Section 300.430(e)(2) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). Specifically, 40 CFR 300.430(e)(2)(i) states that, "[I]nitially, preliminary remediation goals are developed based on readily available information, such as chemical-specific ARARs or other reliable information. Preliminary remediation goals should be modified, as necessary, as more information becomes available during the Remedial Investigation/Feasibility Study (RI/FS). Final remediation goals will be determined when the remedy is selected." Using programmatic exposure scenarios also expedites the overall remediation schedule for OU6 by allowing the Corrective Measures Study/Feasibility Study (CMS/FS) to proceed through early identification of data needs to support the evaluation of potential remedial alternatives. Should the final HHRA and/or ERA indicate that the remediation targets selected for OU6 are not representative of the actual risk posed by the contaminated media, the required changes will be incorporated as early as possible during the development of the CMS/FS.

This Technical Memorandum contains five sections, including this introduction, plus five appendices. Section 2.0 provides background information for OU6 and briefly summarizes major findings of the RFI/RI and discusses the identification and distribution of COCs for OU6. The C/RAOs and remediation targets developed for the OU6 COCs are described in Sections 3.0 and 4.0, respectively. Section 5.0 presents recommendations, such as No Further Action, to streamline subsequent CMS/FS efforts. References used to prepare this Technical Memorandum are also included. Appendix A contains brief descriptions of OU6 IHSSs for reference. Appendices B and C contain the exposure factors and chemical-specific toxicity information used to calculate the risk-based PRGs. Appendix D contains the risk-based PRG equations and exposure factors for the OU6-specific sediment exposure scenario. Appendix E contains a list of the potential chemical-specific ARARs/TBCs that were considered in selecting the OU6 remediation targets.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Background
Revision B - Draft	Page	2-1
February, 1995	Organization	ER OU 5, 6, & 7 Closures

2.0 BACKGROUND

OU6 is one of 16 operable units at the RFETS and, as shown in Figure 2-1, is located in the northeastern quadrant of the RFETS industrial area and buffer zone. The 19 IHSSs contained within OU6 are shown in Figure 2-2 and include

- Sludge Dispersal Area (IHSS 141),
- A-series and B-series Retention Ponds (IHSSs 142 1 through 142 9),
- Walnut and Indiana Pond (IHSS 142 12),
- Old Outfall (IHSS 143),
- Soil Dump Area (IHSS 156 2),
- Triangle Area (IHSS 165),
- Trenches (IHSSs 166 1, 166 2, and 166 3),
- North Area Spray Field (IHSS 167 1), and
- East Area Spray Field (IHSS 216 1)

In addition to the above, IHSS 167 2 (Pond Area Spray Field) and IHSS 167 3 (South Area Spray Field) were originally included as part of the RFI/RI work plan for OU6. During the course of the OU6 characterization activities, it was determined that the South Area Spray Field was actually located further north, adjacent to the landfill pond. Considering that the landfill is the most likely source of potential contamination, both IHSSs 167 2 and 167 3 were administratively transferred to OU7 for investigation and any subsequent remediation. However, the environmental data that were collected for the original suspected location for IHSS 167 3 is being retained to assess the remediation needs for OU6. The original IHSS 167 3 location has been designated as the Former South Area Spray Field (F167 3) in order to distinguish it from the current IHSS 167 3 being addressed as part of OU7. Although F167 3 is being retained for completeness, this location is not formally considered an IHSS.

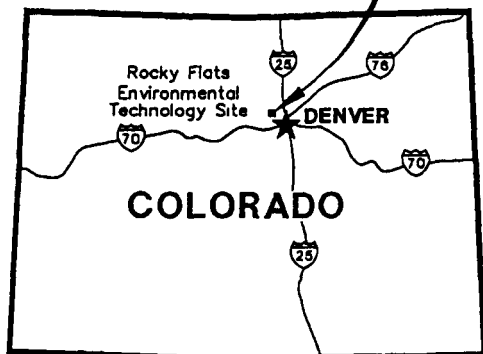
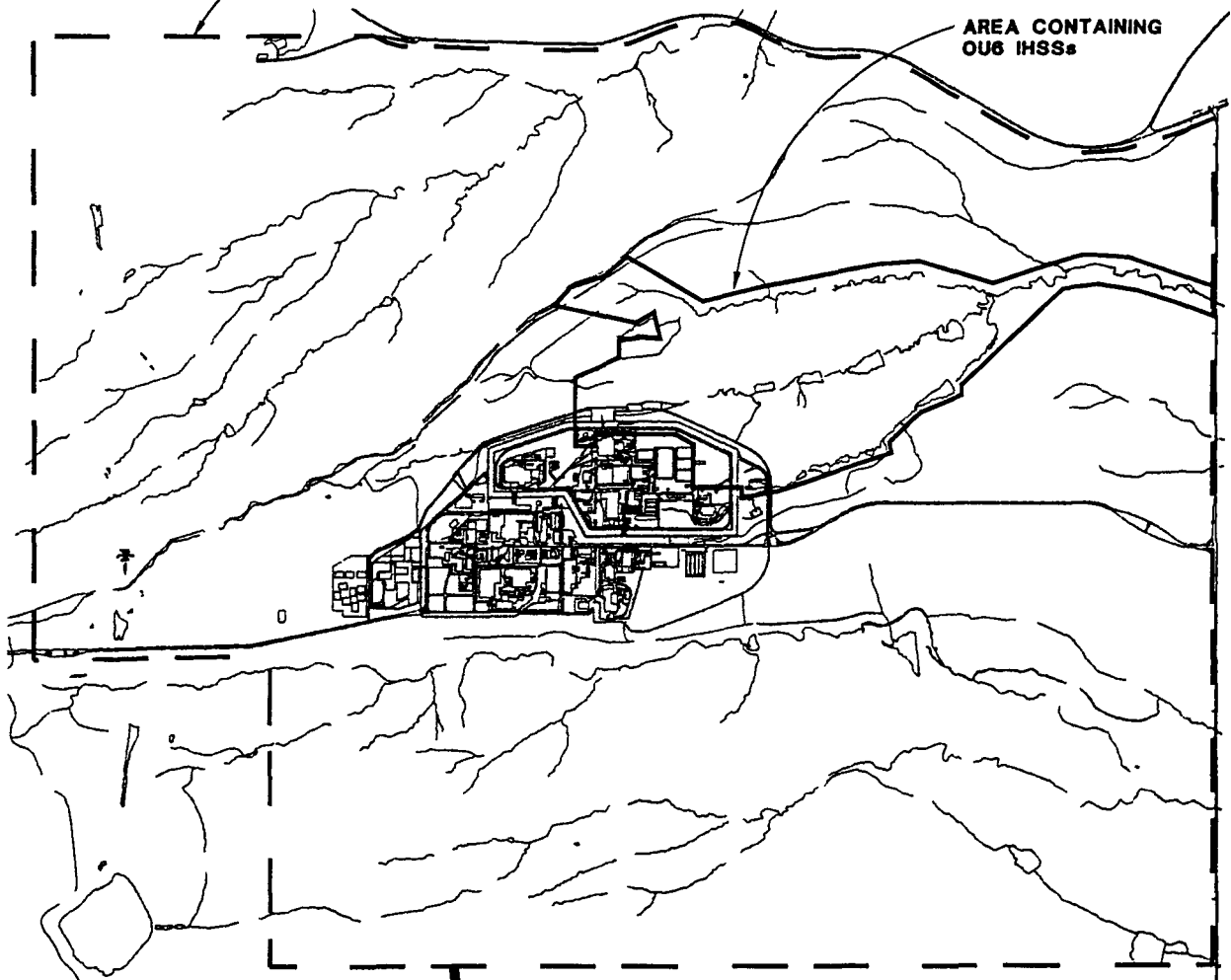
Additional descriptions and historical information associated with each IHSS or location are presented in Appendix A. Subsection 2.1 presents the methodology used to establish the COCs for OU6 and Subsection 2.2 summarizes the characterization information for each environmental media.

2.1 Chemicals of Concern

Chemicals of Concern (COCs) are defined as compounds that are either (1) statistically greater than their corresponding background concentrations, (2) where background information does not exist, detected at a frequency to pose a concern, or (3) present at limited locations in a sufficiently high concentration to pose a special concern to human health or the environment. The

ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE BOUNDARY

AREA CONTAINING
OU6 IHSSs



PREPARED FOR
U S DEPARTMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE
GOLDEN, COLORADO

Figure 2-1

Location Map
Operable Unit No 6
Technical Memorandum No 1

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Background
Revision B - Draft	Page	2-4
February, 1995	Organization	ER OU 5, 6, & 7 Closures

COCs for OU6 are based on both human health and environmental considerations. These COCs form the basis for developing the C/RAOs and remediation targets presented in this Technical Memorandum. The following subsections present the human health and environmental COCs that have been identified for OU6.

2.1.1 Human Health Chemicals of Concern

Table 2-1 provides the human health COCs for each environmental medium as presented in Technical Memorandum No 4 (DOE, 1994a). The "Xs" in this table indicate which chemicals have been identified as a human health COC on an environmental medium basis. The human health COCs identified for OU6 include metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOC), polynuclear aromatic hydrocarbons (PAHs), a polychlorinated biphenyl (PCB), nitrate, and radionuclides. Special-case COCs (e.g., vinyl chloride for groundwater) are also included in Table 2-1.

2.1.2 Environmental Chemicals of Concern

The scope of the ERA does not focus specifically on OU6, but encompasses the entire Walnut Creek watershed. In addition to the Walnut Creek ERA, a separate ERA is being prepared for the Woman Creek watershed. However, the Woman Creek ERA findings are not germane to OU6. A list of environmental COCs and their potential impact to environmental receptors have not been completely assessed at this time. In the absence of quantitative exposure pathways to environmental receptors, it is assumed that the remediation targets established for the protection of human health will also be protective of the environment. This assumption will allow the development and screening of remedial technologies to progress for OU6. Should completion of the ERA indicate that more stringent remediation targets need to be established to ensure protection of the environment, the CMS/FS documents will be revised accordingly.

2.2 Environmental Media Contamination

It is proposed that the C/RAOs, remediation targets, and subsequent remedial alternatives, if required, be developed on a contaminated media basis. For the purpose of this Technical Memorandum, potentially contaminated areas are defined as those IHSS areas where COC concentrations exceed the corresponding remediation targets selected for environmental media. These contaminated areas may require remediation if the final BRA results so dictate. Table 2-2 shows, for each IHSS, the environmental media that was included as part of the RFI/RI characterization program. The RFI/RI Work Plan was structured so that characterization samples would not be collected from areas which were not suspected to be contaminated. The Table 2-2

TABLE 2-1
HUMAN HEALTH CHEMICALS OF CONCERN
BY ENVIRONMENTAL MEDIA

Chemical	Surface Soil	Subsurface Soil	Sediment		UHSU Ground-water	Surface Water
			Pond	Stream		
Acetone	--	--	--	--	--	X
Antimony	X ^{a/}	--	X	--	--	--
Aroclor-1254	--	--	X	--	--	--
Barium	--	X	--	--	--	--
Benzo(a)anthracene	--	--	--	X	--	--
Benzo(a)pyrene	--	X	X	X	--	--
Benzo(b)fluoranthene	--	X	X	X	--	--
Bis(2-ethylhexyl)phthalate	--	--	X	--	--	--
Chloroform	--	--	--	--	X	X
Cobalt	--	--	--	X	--	--
1,2-Dichloroethene	--	--	--	--	--	X
Indeno(1,2,3-cd)pyrene	--	--	--	X	--	--
Methylene Chloride	--	X	--	--	X	X
Nitrate	--	--	--	--	X	--
Silver	X	--	X	--	--	--
Strontium	--	--	--	X	--	--
Tetrachloroethene	--	--	--	--	X	--
Trichloroethene	--	--	--	--	X	X
Vanadium	X	--	X	X	--	--
Vinyl Chloride	--	--	--	--	X	--
Zinc	X	--	X	X	--	--
Americium-241	X	X	X	X	X	--
Plutonium-239/240	X	X	X	X	X	--
Radium-226	--	--	--	--	X	--
Uranium-233/234	--	X	--	--	--	--
Uranium-238	--	X	--	--	--	--

SOURCE Chemicals of Concern listed in Technical Memorandum No 4 (DOE, 1994a)
^{a/} "X" indicates Chemical of Concern detected above background in environmental medium

TABLE 2-2
ENVIRONMENTAL MEDIA SAMPLED DURING OU6 RFI/RI

IHSS or Location	Surface Soil	Subsurface Soil	Sediment ^{b/}	UHSU Ground-water	Surface Water
Sludge Dispersal Area (IHSS 141)	X ^{a/}	--	--	X	--
Pond A-1 (IHSS 142 1)	--	--	X	X	X
Pond A-2 (IHSS 142 2)	--	--	X	X	X
Pond A-3 (IHSS 142 3)	--	--	X	X	X
Pond A-4 (IHSS 142 4)	--	--	X	X	X
Pond B-1 (IHSS 142 5)	--	--	X	X	X
Pond B-2 (IHSS 142 6)	--	--	X	X	X
Pond B-3 (IHSS 142 7)	--	--	X	X	X
Pond B-4 (IHSS 142 8)	--	--	X	X	X
Pond B-5 (IHSS 142 9)	--	--	X	X	X
Walnut and Indiana Pond (IHSS 142 12)	--	--	X	X	X
Old Outfall (IHSS 143)	X	X	--	X	--
Soil Dump Area (IHSS 156 2)	X	X	--	--	--
Triangle Area (IHSS 165)	X	X	--	X	--
Trench A (IHSS 166 1)	--	X	--	X	--
Trench B (IHSS 166 2)	--	X	--	X	--
Trench C (IHSS 166 3)	--	X	--	X	--
North Area Spray Field (IHSS 167 1)	X	X	--	--	--
Former South Area Spray Field (F167 3)	X	X	--	X	--
East Area Spray Field (IHSS 216 1)	X	X	--	--	--

NOTES

^{a/} "X" indicates that the environmental media was sampled during the RFI/RI

^{b/} Sediments includes both ponds and stream beds

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Background
Revision B - Draft	Page	2-7
February, 1995	Organization	ER OU 5, 6, & 7 Closures

cells without "Xs" represent the IHSS media not suspected to be contaminated. These IHSS media are therefore not included in developing C/RAOs and remediation targets for OU6.

The COCs identified for groundwater are based on OU6 RFI/RI analytical results for the upper hydrostratigraphic unit (UHSU) which includes both the Rocky Flats Alluvium and the No. 1 Sandstone lithologic units. Although the capability of the UHSU aquifer to produce a sufficient quantity of groundwater for domestic use is questionable, the residential use exposure scenario was used as the basis for developing C/RAOs and remediation targets. If the results of the OU6 RFI/RI indicate that UHSU aquifer cannot support a water supply well for domestic use within OU6, more appropriate exposure scenarios may be evaluated.

This Technical Memorandum recommends No Further Action for IHSSs where all of the COC concentrations for each environmental medium are below the selected remediation targets. To assist with determining which IHSSs are candidates for a No Further Action recommendation, historical release information and RFI/RI characterization results were evaluated on an IHSS-by-IHSS basis. The COCs identified for each environmental medium and IHSS-specific characterization information are further addressed in the subsections that follow. Additional information regarding the OU6 IHSSs can be found in the *Phase I RFI/RI Workplan for OU6 - Walnut Creek Priority Drainage* (EG&G, 1992) and *The Historical Release Report* (DOE, 1992). Brief descriptions and historical summaries for each IHSS are provided in Appendix A.

Cause and effect relationships between potential sources of contamination and the COCs detected in the IHSS media have not been verified. As such, the cause/effect relationships presented in this section and Appendix A are based on the best currently available information. Descriptions of these potential contaminant sources are being provided to ensure that they are properly considered when establishing C/RAOs and developing remedial alternatives. For example, remediation of a known or suspected contaminant source may need to be conducted prior to remediating OU6 to prevent recontamination of remediated areas. Cause and effect relationships are being further evaluated as part of the RFI/RI. The discussions presented in this Technical Memorandum are not intended to preclude other conclusions being developed for the RFI/RI report.

2.2.1 Surface Soil

The OU6 surface soils are defined as the top two inches of each IHSS sampled for surface soils within OU6. Those IHSSs with suspected surface soil contamination have been sampled under the RFI/RI for OU6. Surface soils not characterized as part of the RFI/RI are not suspected to be contaminated. The COCs for the OU6 surface soil include antimony, silver, vanadium,

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Background
Revision B - Draft	Page	2-8
February, 1995	Organization	ER OU 5, 6, & 7 Closures

zinc, americium-241, and plutonium-239/240 Table 2-3 summarizes the occurrence of OU6 surface soil COCs by IHSS in which they were detected

Based on the *Final Historical Release Report* (DOE, 1992), it is inferred that the COCs detected in OU6 surface soil may be the result of

- Contaminant migration from the 903 Pad Drum Storage Site,
- A Pu-contaminated sludge spill at the Sludge Dispersal Area,
- Discharge of waste waters (i.e., Building 771 laundry effluent, analytical laboratory and radiography sink wastes) at the 771 Outfall,
- Wind blown salts from the Solar Evaporation Ponds,
- Leaking drums once present at the Triangle Area,
- Possible disposal at the trenches south of the present OU7 landfill,
- Excavated Pond B-2 sediments and soil from the Building 774, once placed at the soil dump area, and/or
- OU7 landfill leachate which was sprayed onto the ground

2.2.2 Subsurface Soil

The OU6 subsurface soils are defined as all soils deeper than two inches for each IHSS sampled for subsurface soil within OU6 The COCs for the OU6 subsurface soil include barium, benzo(a)pyrene, benzo(b)fluoranthene, methylene chloride, americium-241, plutonium-239/240, uranium-233/234, and uranium-238 Table 2-4 summarizes the occurrence of OU6 subsurface soil COCs by the IHSS in which they were detected

Based on the *Final Historical Release Report* (DOE, 1992), it is inferred that the COCs detected in the OU6 subsurface soil may be the result of

- Contaminant migration from the Pu-contaminated sludge spill at the Sludge Dispersal Area,
- Discharge of waste waters at the 771 Outfall,
- Leaking drums once present at the Triangle Area,
- Possible disposal at the trenches south of the present landfill, and/or
- Infiltration of the leachate at the Landfill Spray Fields

The potential exposure pathway evaluated in this Technical Memorandum is for the exposure of a construction worker to subsurface soils In addition to this exposure pathway, the potential for migration of VOCs from the Triangle Area (IHSS 165) subsurface soils into onsite buildings is also being modelled within the RFI/RI However, soil gas measurements taken from

TABLE 2-3
SURFACE SOIL CHEMICALS OF CONCERN BY IHSS

Surface Soil Chemical of Concern ^{a/}	Sludge Dispersal Area	Old Outfall	Soil Dump Area	Triangle Area	North Area Spray Field	Former South Area Spray Field	East Area Spray Field
	IHSS 141	IHSS 143	IHSS 156 2	IHSS 165	IHSS 167 1	F167 3	IHSS 216 1
Antimony	--	--	X	--	--	--	--
Silver	X ^{b/}	--	--	--	--	--	--
Vanadium	X	X	X	--	--	--	--
Zinc	X	X	X	X	--	X	--
Americium-241	X	--	X	X	X	X	X
Plutonium-239/240	X	X	X	X	X	X	X

NOTES

^{a/} Chemicals of Concern from Technical Memorandum No 4 (DOE, 1994a)

^{b/} "X" indicates that the chemical is identified as a COC within IHSS

TABLE 2-4
SUBSURFACE SOIL CHEMICALS OF CONCERN BY IHSS

Subsurface Soil Chemical of Concern ^{a/}	Old Outfall	Soil Dump Area	Triangle Area	Trench A	Trench B	Trench C	North Area Spray Field	Former South Area Spray Field	East Area Spray Field
	IHSS 143	IHSS 156 2	IHSS 165	IHSS 166 1	IHSS 166 2	IHSS 166 3	IHSS 167 1	F167.3	IHSS 216 1
Barium	X ^{b/}	X	X	X	X	X	X	--	X
Benzo(a)pyrene	X	--	X	--	--	--	--	--	--
Benzo(b)fluoranthene	X	--	X	--	--	--	--	--	--
Methylene Chloride	X	X	X	X	X	X	--	X	X
Americium-241	X	X	X	--	X	X	X	X	X
Plutonium-239/240	X	X	X	X	--	X	X	X	X
Uranium-233/234	--	--	--	--	--	--	X	--	--
Uranium-238	X	--	X	--	--	--	X	--	--

NOTES

^{a/} Chemicals of Concern from Technical Memorandum No 4 (DOE, 1994a)

^{b/} "X" indicates that the chemical is identified as a COC within IHSS

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Background
Revision B - Draft	Page	2-11
February, 1995	Organization	ER OU 5, 6, & 7 Closures

the Triangle Area does not indicate that the subsurface soils is a source of potential contaminants to the groundwater. If VOC migration is determined to be a potential concern, this pathway will be appropriately incorporated into the selected remedial alternative.

2.2.3 Pond and Stream Sediment

The OU6 sediments consist of material deposited within stream beds and retention ponds. Potential pond and stream sediment contamination are restricted to IHSSs 142 1 through 142 9, 142 12 and the Walnut Creek stream beds for OU6. Background concentrations for pond sediments were calculated independently of background concentrations for stream sediments as presented in the *Final Background Geochemical Characterization Report* (DOE, 1993). The identification of COCs for pond and stream sediments were also developed independently. As such, pond and stream sediments are evaluated separately in this Technical Memorandum.

Table 2-5 summarizes the occurrence of pond and stream sediment COCs by the IHSS in which they were detected. Pond sediment COCs include antimony, Aroclor-1254, benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, silver, vanadium, zinc, americium-241, and plutonium-239/240. Stream sediment COCs include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, cobalt, indeno(1,2,3-cd)pyrene, strontium, vanadium, zinc, americium-241, and plutonium-239/240.

Based on the *Final Historical Release Report* (DOE, 1992), it is inferred that the COCs detected in sediments at OU6 may be the result of

- Discharge of Building 995 sanitary waste water treatment plant effluent,
- Discharge of evaporator condensate and untreated process waste from Building 774, and/or
- Discharge of untreated laundry waste water from Buildings 442, 771, 778, and 881,

Runoff from the industrial area may also be a source of COCs detected in the OU6 sediments.

2.2.4 Upper Hydrostratigraphic Unit Groundwater

Within OU6, the UHSU is comprised of variably- and, seasonally-saturated portions of the unconsolidated surficial deposits (Rocky Flats Alluvium and Colluvium) and the Arapahoe Formation No. 4 Sandstone, which may be hydraulically connected to the saturated surficial deposits, and underlying weathered claystone of the Arapahoe Formation. Groundwater flow

TABLE 2-5
SEDIMENT CHEMICALS OF CONCERN BY IHSS

Sediment Chemical of Concern ^{a/}	Pond A-1	Pond A-2	Pond A-3	Pond A-4	Pond B-1	Pond B-2	Pond B-3	Pond B-4	Pond B-5	Walnut & Indiana Pond	Stream Sediments
	IHSS 142 1	IHSS 142 2	IHSS 142 3	IHSS 142 4	IHSS 142 5	IHSS 142 6	IHSS 142 7	IHSS 142 8	IHSS 142 9	IHSS 142 12	
Antimony	--	--	--	X	--	--	X	--	--	--	--
Aroclor-1254	X ^{b/}	X	--	--	X	X	X	X	--	--	--
Benzo(a)anthracene	--	--	--	--	--	--	--	--	--	--	X
Benzo(a)pyrene	X	X	X	--	X	X	X	X	--	--	X
Benzo(b)fluoranthene	X	--	X	--	X	--	X	X	--	--	X
Bis(2-ethylhexyl)phthalate	X	X	X	X	X	X	X	X	X	X	--
Cobalt	--	--	--	--	--	--	--	--	--	--	X
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	X
Silver	--	--	--	--	X	X	X	X	--	--	--
Strontium	--	--	--	--	--	--	--	--	--	--	X
Vanadium	--	--	X	X	--	--	--	--	--	--	X
Zinc	X	X	X	X	X	X	X	X	X	--	X
Americium-241	X	X	--	--	X	X	X	X	--	--	X
Plutonium-239/240	X	X	--	--	X	X	X	X	--	--	X

NOTES

^{a/} Chemicals of Concern from Technical Memorandum No 4 (DOE, 1994a)

^{b/} "X" indicates that the chemical is identified as a COC within IHSS

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Background
Revision B - Draft	Page	2-13
February, 1995	Organization	ER OU 5, 6, & 7 Closures

within the UHSU at OU6 is generally to the east toward topographic lows. Flow direction is expected to vary locally near each surface impoundment due to recharge from each pond and by the removal of the alluvial sediments in this area during pond construction.

The UHSU in OU6 is subdivided into six groundwater areas as shown on Figure 2-2. The boundaries of the groundwater areas are based on the variable or seasonal occurrence of groundwater in OU6 and represent isolated areas of recharge and groundwater flow among the various IHSSs at OU6. Results from the Phase I RFI/RI investigation have indicated that chemicals detected in the groundwater at OU6 are limited to the UHSU and to previously identified groundwater areas. Characterization of groundwater adjacent to IHSS 156 2 (Soil Dump Area), IHSS 167 1 (North Area Spray Field), and IHSS 216 1 (East Area Spray Field) was not included as part of the RFI/RI Work Plan, either UHSU groundwater is not present in these areas or is not suspected to be impacted. As such, these IHSSs are not listed in Table 2-2 as part of the groundwater medium.

The COCs for the OU6 groundwater include chloroform, methylene chloride, nitrate, tetrachloroethene, trichloroethene, vinyl chloride, americium-241, plutonium-239/240, and radium-226. Although vinyl chloride was detected at only 1 well (Well #3568), it was detected at a relatively high concentration (860 $\mu\text{g/L}$). Vinyl chloride was identified as a special case COC since it is considered to be highly toxic. Table 2-6 presents these COCs as detected in various groundwater areas across OU6.

Based on potential contaminant sources and releases presented in the *Final Historical Release Report* (DOE, 1992), the potential sources of the chemicals detected in UHSU groundwater at OU6 is inferred to be the result of contaminant migration from upgradient sources (i.e., nitrate seepage from the solar evaporation ponds area and possible releases from Building 774). The chemicals detected in the groundwater in the vicinity of IHSSs 166 1, 166 2, 166 3 and 167 3 may be the result of leachate migration from the upgradient OU7 landfill or the OU10 Property Utilization and Disposal yard.

2.2.5 Surface Water

Surface water in OU6 is restricted to IHSSs associated with the Walnut Creek drainage basin including North and South Walnut Creeks, and No Name Gulch. These three forks of Walnut Creek converge in the buffer zone and flow to the east. The natural drainage of both North and South Walnut Creeks has been modified in the OU6 area by the construction of several retention ponds (i.e., IHSSs 142 1 through 142 9, and 142 12). Surface water samples were collected from inlets, spillways, the deepest part of each pond, and at random locations within each pond at OU6.

TABLE 2-6
GROUNDWATER CHEMICALS OF CONCERN BY GROUNDWATER AREA

Groundwater Chemical of Concern ^{a/}	Groundwater Area 1 ^{b/}	Groundwater Area 2 ^{c/}	Groundwater Area 3 ^{d/}	Groundwater Area 4 ^{e/}	Groundwater Area 5 ^{f/}	Groundwater Area 6 ^{g/}
Chloroform	X ^{h/}	X	--	--	--	X
Methylene Chloride	X	X	X	X	X	X
Nitrate	--	X	--	--	--	--
Tetrachloroethene	X	X	X	X	--	X
Trichloroethene	X	X	X	X	--	X
Vinyl Chloride	--	--	X	--	--	--
Americium-241	X	X	X	--	X	X
Plutonium-239/240	--	X	X	--	X	X
Radium-226	--	X	--	--	X	X

NOTES

^{a/} Chemical of Concern from Technical Memorandum No 4 (DOE, 1994a)

^{b/} Associated IHSSs include 166 1, 166 2, 166 3, and F167 3

^{c/} Associated IHSSs include 142 1, 142 2, 142 3, and 142 4

^{d/} Associated IHSSs include 141, 142 5, 142 6, 142 7, 142 8, and 142 9

^{e/} Associated with IHSS 165

^{f/} Associated with IHSS 142 12

^{g/} Associated with IHSS 143

^{h/} "X" indicates that the chemical is identified as a COC within Groundwater Area

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Background
Revision B - Draft	Page	2-15
February, 1995	Organization	ER OU 5, 6, & 7 Closures

The COCs for the OU6 surface water include acetone, chloroform, 1,2-dichloroethene, methylene chloride, and trichloroethene. These organic compounds were detected at low levels in surface water at OU6. Table 2-7 summarizes the occurrence of these COCs by IHSS in which they were detected.

Based on potential contaminant sources and releases presented in the *Final Historical Release Report* (DOE, 1992), the organic chemicals detected in OU6 surface water are inferred to be the result of discharges from the Building 995 sanitary waste water treatment plant, and possibly storm water runoff from the industrial area.

TABLE 2-7
SURFACE WATER CHEMICALS OF CONCERN BY IHSS

Surface Water Chemical of Concern ^{a/}	Pond A-1	Pond A-2	Pond A-3	Pond A-4	Pond B-1	Pond B-2	Pond B-3	Pond B-4	Pond B-5	Walnut & Indiana Pond
	IHSS 142.1	IHSS 142.2	IHSS 142.3	IHSS 142.4	IHSS 142.5	IHSS 142.6	IHSS 142.7	IHSS 142.8	IHSS 142.9	IHSS 142.12
Acetone	--	--	--	--	X ^{b/}	X	X	X	X	X
Chloroform	--	--	--	--	--	--	X	X	X	--
1,2-Dichloroethene	--	--	--	--	--	X	--	--	--	--
Methylene Chloride	--	--	--	--	--	--	X	X	--	--
Trichloroethene	--	--	--	--	--	X	--	X	--	--

NOTES

^{a/} Chemicals of Concern from Technical Memorandum No. 4 (DOE, 1994a)

^{b/} "X" indicates that the chemical is identified as a COC within IHSS

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Corrective/Remedial Action
Revision B - Draft		Objectives for OU6
February 27, 1995	Page	3-1
	Organization	ER OU 5, 6, & 7 Closures

3.0 CORRECTIVE/REMEDIAL ACTION OBJECTIVES FOR OU6

The IAG requires that an appropriate range of C/RAOs be established to screen and evaluate corrective/remedial alternatives. The C/RAOs are, at a minimum, to be developed to ensure protection of human health and the environment. These objectives shall specify the contaminants and media of interest, exposure pathways, and acceptable levels or ranges of levels for each exposure route.

The corrective action objectives were identified to ensure that applicable RCRA hazardous waste management requirements are properly considered during development of the CMS/FS. For those remediation wastes determined to be hazardous, proper management will be incorporated into implementation of the selected remedial alternative.

The remedial action objectives were identified to ensure that applicable Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) cleanup requirements are properly considered. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988) discusses development of remedial action objectives and PRGs. Remedial action objectives are chemical- and medium-specific goals for protecting human health and the environment. In developing appropriate remedial action objectives, the EPA guidance document states that "objectives should be as specific as possible, but not so specific that the range of alternatives that can be developed is unduly limited." The guidance also specifies that in order to quantify remedial action objectives, preliminary remediation goals are to be developed that identify an acceptable target contaminant level or range of levels for each exposure route of concern.

The combined consideration of RCRA corrective and CERCLA remedial action objectives will ensure integration of these two environmental protection programs and their implementation into the remediation efforts for OU6. The media-specific C/RAOs that have been identified for OU6 are listed below:

- Remediate contaminated surface and/or subsurface soils to non-zero chemical-specific ARARs/TBCs, as appropriate. In the absence of chemical-specific ARARs/TBCs, prevent exposure to contaminated surface and/or subsurface soils that would result in a total excess cancer risk greater than 10^{-4} to 10^{-6} or a hazard index of greater than 1 for noncarcinogens.
- Remediate contaminated pond and/or stream sediments to non-zero chemical-specific ARARs/TBCs, as appropriate. In the absence of chemical-specific

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Corrective/Remedial Action
Revision B - Draft		Objectives for OU6
February 27, 1995	Page	3-2
	Organization	ER OU 5, 6, & 7 Closures

ARARs/TBCs, prevent exposure to contaminated pond and/or stream sediments that would result in a total excess cancer risk greater than 10^{-4} to 10^{-6} or a hazard index of greater than 1 for noncarcinogens

- Remediate the groundwater aquifer (e g , UHSU) to non-zero chemical-specific ARARs/TBCs, as appropriate In the absence of chemical-specific ARARs/TBCs, prevent exposure to contaminated groundwater that would result in a total excess cancer risk of greater than 10^{-4} to 10^{-6} or a hazard index greater than 1 for noncarcinogens
- Provide source controls to prevent migration of contaminants that would result in groundwater contamination in excess of the selected remediation targets for groundwater
- Remediate the surface water to non-zero chemical-specific ARARs/TBCs, as appropriate In the absence of chemical-specific ARARs/TBCs, prevent exposure to contaminated surface water that would result in a total excess cancer risk of greater than 10^{-4} to 10^{-6} or a hazard index greater than 1 for noncarcinogens
- Select a remedial alternative that eliminates potential exposure to environmental receptors and that minimizes potential impacts to environmental receptors during implementation Since the ERA has not yet been completed, it is assumed for the purpose of this Technical Memorandum environmental receptors will be adequately protected based on achieving the C/RAOs established for the protection of human health

The OU6 C/RAOs were developed using appropriate regulatory guidelines (EPA, 1988) and the NCP, and by considering both programmatic and OU6-specific human health exposure pathways, and the fate of identified COCs (see Section 4.0 of this Technical Memorandum) Should the BRA (e g , HHRA or the ERA for Walnut Creek drainage basin) identify additional exposure pathways not addressed, the C/RAOs will be revised accordingly and incorporated as part of the CMS/FS The above C/RAOs are not intended to establish cleanup levels which are below background or analytical detection levels, or which cannot be achieved through the application of current technologies In addition to considering the technical feasibility of achieving the selected remediation targets, remedial alternatives will be developed and selected on the basis of their cost-effectiveness If necessary, CERCLA waivers or other regulatory-provided variances will be sought when unreasonable remediation targets are required to be established

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-1
February, 1995	Organization	ER OU 5, 6, & 7 Closures

4.0 REMEDIATION TARGETS FOR OU6

This section identifies the remediation targets that have been selected for each OU6 environmental media. The selected remediation targets will form the basis for developing and evaluating remedial technologies and alternatives for OU6. Although parts of the RFI/RI yet to be completed may influence the selection of final remediation goals for OU6, the establishment of remediation targets will allow the CMS/FS to proceed. The remediation targets may need to be modified as the CMS/FS progresses. Final remediation goals that are mutually agreeable to the participating agencies (i.e., DOE, EPA, and CDPHE) will be identified in the Record of Decision (ROD) for OU6. A brief description of the information sources considered in selecting the remediation targets for OU6 are described in Section 4.1. The specific information used and the rationale for selecting the remediation targets for each OU6 environmental media (e.g., surface soils, subsurface soils, sediments, groundwater, and surface water) are discussed in Sections 4.2 through 4.6.

4.1 Resources for Identifying Potential Remediation Targets

The NCP and EPA's RI/FS guidance documents require the establishment of PRGs that specify the degree of cleanup the remedial action must achieve to protect human health and the environment. PRGs are environmental media- and contaminant-specific values developed on the basis of chemical-specific ARARs, site-specific risk-related factors, and other readily available information. For known or suspected carcinogens, the 10^{-6} carcinogenic risk level is to be used as the point of departure for determining remediation goals for remedial alternatives when ARARs are not available or are not sufficiently protective of human health and the environment [40 CFR 300.430(e)(2)((i)(A)(2))]. This subsection describes the resources that were considered in selecting the remediation targets for OU6. These resources include background chemical concentrations, potential chemical-specific ARARs/TBCs, programmatic risk-based PRGs, and other readily available information (e.g., background concentrations, minimum analytical detection limits, and cleanup standards invoked at other sites in the State of Colorado).

4.1.1 Chemical-Specific ARARs

The DOE is responsible for identifying those promulgated standards, requirements, criteria, or limitations (i.e., ARARs) to be met during implementation of the selected remedy. *Applicable* requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental, or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. *Relevant and Appropriate* requirements are those cleanup standards, standards of control, and other substantive

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-2
February, 1995	Organization	ER OU 5, 6, & 7 Closures

requirements, criteria, or limitations promulgated under Federal environmental, or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only State standards that are promulgated and identified in a timely manner by the State, and are more stringent than Federal requirements qualify as ARARs. For purposes of identification and notification of State standards, the term "promulgated" means that the standards are of general applicability and are legally enforceable.

In addition to ARARs, other non-promulgated advisories, criteria, or guidance documents (e.g., TBCs) are evaluated along with potential ARARs. TBCs are not legally binding, and do not have the status as potential ARARs. Although the use of TBCs is discretionary, TBCs can be used, in the absence of ARARs or where ARARs are not considered to be sufficiently protective to develop the remediation targets for OU6.

This Technical Memorandum only addresses the identification of potential chemical-specific ARARs/TBCs for the purpose of developing remediation targets for the OU6 COCs. Action- and location-specific ARARs will be addressed during the initial screening of remedial alternatives for OU6 and will be presented as part of the CMS/FS for OU6. Chemical-specific ARARs are health- or risk-based numerical values that establish the acceptable amount or concentration of a compound that may be found in or discharged to the ambient environment (e.g., air emissions or waste water discharges). Chemical-specific ARARs may also include methodologies which, when applied to site-specific conditions, result in the establishment of numerical values that are protective of human health and/or the environment. The potential chemical-specific ARARs/TBCs presented in this Technical Memorandum are consistent with the ARAR identification process contained in the *Draft Master List of Potential Federal and State ARARs for the Rocky Flats Environmental Technology Site* (DOE, 1994c) and subsequent discussions held between DOE, EPA, and CDPHE.

4.1.2 Risk-Based Preliminary Remediation Goals

When potential chemical-specific ARARs are not available or are not considered sufficiently protective because of the presence of multiple contaminants or multiple exposure pathways, calculated risk-based values can be used to establish contaminant levels that are considered to be protective of human health. As previously discussed, the risk characterization components of the BRA have not been finalized for OU6. Potential exposure routes and receptors to be used in the HHRA for OU6 are currently being refined. In addition, the ecological COCs, receptors, and exposure pathways are being evaluated to determine measures that may be required to adequately protect the environment.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-3
February, 1995	Organization	ER OU 5, 6, & 7 Closures

In an effort to proceed with the CMS/FS for OU6, programmatic exposure pathways were developed for human health exposures and used in calculating risk-based PRGs. Table 4-1 summarizes the programmatic exposure routes and human receptors. These programmatic exposure pathways include viable exposure routes that will most likely be addressed in the HHRA for OU6. Should the HHRA identify additional exposure pathways not programmatically addressed, the required changes will be incorporated during development of the CMS/FS. The methodology and equations used to calculate the programmatic risk-based PRGs are presented in *Programmatic Risk-Based Preliminary Remediation Goals* (DOE, 1995). Since environmental media considered for calculating the programmatic risk-based PRGs does not include sediments, an OU6-specific exposure scenario was developed to address potential exposure to contaminated sediments based on recreational use of the streams and ponds by onsite residents. Details regarding this sediment exposure pathway are presented in Section 4.4.3 of this Technical Memorandum.

EPA's Risk Assessment Council states that all risk assessments are to be based on two different exposure levels which include the reasonable maximum exposure (RME) and the central tendency (CT). As such, risk-based PRGs were calculated using both the RME and CT exposure levels. The NCP requires sites to be remediated so that the lifetime risk to an individual is between 10^{-4} to 10^{-6} for known or suspected carcinogens. As such, the RME and CT risk-based PRGs for carcinogens were calculated by setting the carcinogenic target risk level at 10^{-6} to be consistent with the NCP. A target risk level of 10^{-6} means an individual has a one-in-one-million probability of developing cancer over a lifetime as a result of an assumed exposure to a specific contaminant. This risk is additional to the probability of an individual developing cancer from other factors such as those associated with heredity or lifestyle.

Similarly, the RME and CT risk-based PRGs for systemic toxicants (e.g., noncarcinogens) were calculated by setting the hazard quotient at one for each contaminant in accordance with the NCP. A hazard quotient is the ratio of a single substance exposure level of a contaminant over a specified period to the reference dose for that chemical. The reference dose represents an estimate of an exposure level for the human population, including sensitive subpopulations, that is likely to be without appreciable deleterious effects during a lifetime. Where a COC exhibits both carcinogenic and non-carcinogenic properties, the more conservative (e.g., lower) RME risk-based PRG was considered in the selection of the remediation target.

The intent of providing both RME and CT risk-based PRGs is to determine the sensitivity of contaminant concentrations with respect to risk. EPA guidance states that for decision-making purposes in the Superfund Program, the RME exposure level should be used to estimate risk and the CT exposure level is presented for comparative purposes only (EPA, 1992). In keeping with this guidance, the more conservative RME risk-based PRGs were considered in establishing an

TABLE 4-1
PROGRAMMATIC EXPOSURE PATHWAYS FOR HUMAN HEALTH

Environmental Media	Human Health Exposure Scenario		
	Residential	Commercial/Industrial	Ecological Researcher
Surface Soil	Direct Ingestion of Soils ^{a/} Inhalation of Particulates ^{b/} External Radiation Exposure	<u>Office Worker Scenario</u> Direct Ingestion of Soils ^{a/} Inhalation of Particulates ^{b/} External Exposure to Radiation	Direct Ingestion of Soils ^{a/} Inhalation of Particulates ^{b/} External Radiation Exposure
Subsurface Soil	Not Applicable	Direct Ingestion of Soils ^{a/} Inhalation of Particulates ^{b/} External Exposure to Radiation Inhalation of Volatiles	Not Applicable
Groundwater	Direct Ingestion of Groundwater ^{a/} Inhalation During Domestic Use ^{c/}	Not Applicable	Not Applicable
Surface Water	Direct Ingestion while Swimming ^{d/}	Not Applicable	Direct Ingestion While Wading ^{d/}

NOTES

^{a/} Includes assessment of organics and inorganics (including radionuclides)

^{b/} Includes assessment of non-volatile organics and inorganics (including radionuclides)

^{c/} Includes assessment of volatile organics

^{d/} Includes assessment of organics

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-5
February, 1995	Organization	ER OU 5, 6, & 7 Closures

appropriate remediation target for each OU6 COC and will also be used in the subsequent screening of remedial alternatives. The RME and CT risk-based PRGs provide a range of cleanup values in assessing potential remediation technologies. During the detailed analysis of remedial action alternatives the CT risk-based PRGs will be considered in conjunction with the RME risk-based PRGs to assess the cost-effectiveness versus risk reduction of the various remedial alternatives.

Appendix B contains a summary of the RME and CT exposure factors used to calculate the risk-based PRGs for this Technical Memorandum. It should be noted that Appendix B contains RME and CT exposure factors for a gravel mine worker scenario. This exposure scenario was deemed to be inappropriate for OU6 due to the limited presence of exploitable quantities of minable materials (See Section 4.2.3 of this Technical Memorandum).

Chemical-specific toxicity information used to calculate both the RME and CT risk-based PRGs for the OU6 COCs are summarized in Appendix C. The toxicity information used to calculate the risk-based PRGs for radionuclides are based on the inclusion of daughter products where appropriate (e.g., uranium-238). Since the plutonium-239 and -240, and uranium-233 and -234 isotopes are reported as a single analyte (i.e., plutonium-239/240 and uranium-233/234, respectively), the reported risk-based PRG value is the lowest of the carcinogen or noncarcinogen risk-based PRG value calculated for the respective isotopes. Using the lowest value is the most conservative approach in establishing remediation targets for these radionuclides. Based upon the stream averages of plutonium isotopes historically processed for weapons reserve, over 99.5% of the total plutonium from production operations can be measured as plutonium-239/240.

4.1.3 Other Readily Available Information

Other information such as background concentrations, minimum analytical detection limits, existing NPDES permitted effluent discharge limits for Walnut Creek, and cleanup standards that have been determined to be protective at other remediation sites were also considered in establishing the OU6 remediation targets. These other factors were used to verify that chemical-specific ARARs and/or calculated risk-based levels are achievable and reasonable.

The background concentration information, as summarized in Technical Memorandum No. 4 for OU6 (DOE, 1994a), was obtained from the *Final Background Geochemical Characterization Report* (DOE, 1993) and background surface soil samples collected in the Rock Creek Area during the 1991 OU1 Phase III investigation and the 1993 OU2 Phase II investigation. The upper tolerance limit (UTL) of background data calculated at the 99 percent confidence level is presented as the background concentration for each COC identified for each media. The

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-6
February, 1995	Organization	ER OU 5, 6, & 7 Closures

background concentration information was used to ensure that a remediation target was not selected which was below background levels and was therefore not achievable

In addition to background concentrations, the minimum analytical detection limit was considered to ensure that achieving the selected remediation target can be verified using standard analytical methods. The minimum analytical detection limit was selected as the remediation target where other ARARs/TBCs and/or risk-based remediation goals are less than the detection limit. The minimum analytical detection limits were obtained from *General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Part A, General Analytical Services Protocol (GASP), Organics, Inorganics, Water Quality Parameters, Biochemistry, Biota - Statement of Work* (EG&G, 1991) and *General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Part B, Radioanalytical Services Protocol (RASP) - Statement of Work* (EG&G, 1991a).

Cleanup standards that were adopted at other remediation sites were derived from reviewing available RODs for CERCLA remedial actions undertaken at sites within the borders of Colorado. An electronic search of EPA's RODS database was performed to obtain a list of Colorado sites where soil remediation was specified. The database was also used to select RODs which address the COCs germane to OU6. The cleanup standards established in these previously issued RODs were not selected as the remediation target. Instead, they were used to provide an indication of the acceptability and reasonableness of the selected remediation target. The previously established cleanup standards were eliminated from consideration in case where the basis for the cleanup standard could not be determined, when the cleanup standard was not reasonable, or was not pertinent to OU6.

Finally, the discharge limitations contained in the NPDES permit for the protection of the water quality classification of Walnut Creek was also considered in selecting the remediation targets for the OU6 surface waters. Since the protection of surface water classifications is to be factored into the establishment of NPDES permit limitations, the discharge limitations were considered in the selection of remediation targets for those chemicals which are specifically identified in the permit.

4.2 Surface Soils

Table 4-2 presents the background concentrations, minimum analytical detection limits, potential chemical-specific ARARs/TBCs, programmatic risk-based PRGs, and cleanup standards established at other Colorado remediation sites that were considered in setting the remediation target for each OU6 surface soil COC. The following subsections provide additional details regarding the source and methods used to identify and select the remediation targets.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-8
February, 1995	Organization	ER OU 5, 6, & 7 Closures

4.2.1 Background Concentrations

The background concentrations for surface soils were obtained from background surface soil samples collected in the Rock Creek Area during the 1991 OU1 Phase III investigation and the 1993 OU2 Phase II investigation as presented in Technical Memorandum No 4 for OU6 (DOE, 1994a)

4.2.2 Potential Chemical-Specific ARARs/TBCs

Federal and State chemical-specific ARARs, which establish levels of protection in surface soils, were not identified for the OU6 COCs. For radionuclides, DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, (DOE, 1990) is considered a TBC for establishing residual radioactivity levels in surface soils. This DOE Order restricts the offsite radiation dose to members of the public to 100 mrem effective dose equivalent per year. The programmatic risk-based PRG equation for an onsite office worker and the RME exposure factors were used to calculate residual radionuclide concentrations in soils. The concentrations presented in Table 4-2 in the TBC column for the radionuclides (americium-241 and plutonium-239/240) equate to an individual effective dose equivalent of 100 mrem per year to an exposed office worker. The contribution of multiple radionuclides to the effective dose equivalent for a specific exposure scenario will be addressed before the final remediation goals are established. The provisions of DOE Order 5400.5 are currently in the process of being promulgated as 10 CFR 834. The annual effective dose limit of 100 mrem is considered a TBC until promulgation of 10 CFR 834, at which time this dose limit will be considered an ARAR.

Nuclear Regulatory Commission (NRC) standards for radionuclides are not considered to be potential ARARs at RFETS. NRC standards are not applicable since DOE is exempt from NRC regulations. Furthermore, NRC standards are not considered to be appropriate since the DOE is required to and has established radiation protection standards for offsite members of the public pursuant to DOE Order 5400.5 which is currently in the process of being promulgated as 10 CFR 834.

4.2.3 Programmatic Risk-Based Preliminary Remediation Goals

The potential future receptors considered for calculating the programmatic risk-based PRGs for surface soil include onsite residents, office workers, and ecological researchers. The exposure pathways considered for each of the hypothetical future receptors encompass direct ingestion of soils, inhalation of particulates, and external radiation exposure. Several of the programmatic risk-based PRGs calculated for zinc exceeded the soil saturation limit (e.g., greater than 100%

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-9
February, 1995	Organization	ER OU 5, 6, & 7 Closures

by weight in the soil matrix) As such, these programmatic risk-based PRG values are reported as "> 1 00e+06" in Table 4-2

4.2.4 Cleanup Standards at Other Colorado Sites

Two RODs for CERCLA sites located in Colorado were identified that contained reference to at least one of the OU6 surface soil COCs the Woodbury Chemical Site and the Martin Marietta, Denver Aerospace Site It should be noted that there was no distinction in the RODs for cleanup standards for surface and subsurface soils As such, comparing the cleanup values from the RODs for soils contained in Table 4-2 against the programmatic risk-based PRGs calculated specifically for surface soils may not be appropriate

The 1986 ROD for the Woodbury Chemical Site contained an action level range for zinc in soil established at a 10^{-6} risk factor However, it is unclear how the 80 mg/kg cleanup standard is based on a carcinogenic risk factor since zinc is not a carcinogen As such, the zinc action level for the Woodbury Chemical Site was not considered to be germane to OU6

The 1990 ROD for the Martin Marietta, Denver Aerospace Site contained an action level for silver in soil based upon RCRA Toxicity Characteristic determination and background concentrations The cleanup standard for silver presented in the Martin Marietta ROD is based on meeting the Land Disposal Restriction (LDR) treatment standard for RCRA hazardous waste specified in 40 CFR 268 Since the LDR cleanup standard is for the leachate extract of the treated soils (e g , Toxic Characteristic Leaching Procedure), it is not directly comparable to the background concentrations and programmatic risk-based PRGs (which are based on total concentrations) listed in Table 4-2

4.2.5 Selection of Remediation Targets for Surface Soils

The selected remediation targets for the OU6 surface soil COCs are presented on Table 4-2 The remediation targets for antimony, silver, vanadium, and zinc are based on the calculated programmatic risk-based PRGs for an office worker scenario utilizing RME exposure factors since corresponding ARARs/TBCs are not available for these OU6 surface soil COCs Although the remediation targets are based on exposures to potential office workers, decisions regarding the future land use for RFETS have not been finalized However, the DOE Rocky Flats Field Office Future Site Use Working Group is expected to recommend onsite residential use should be eliminated from the future land use plan (see meeting minutes, 12/8/94) As such, the office worker scenario was chosen since it best represents the most conservative non-residential exposure scenario that is likely to occur at the RFETS

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-10
February, 1995	Organization	ER OU 5, 6, & 7 Closures

The selected remediation targets for americium-241 and plutonium-239/240 are based on the calculated residual radioactivity levels conforming to the 100 mrem per year radiation dose standard contained in DOE Order 5400.5. This TBC level was selected over other calculated programmatic risk-based PRGs since the NCP requires, in most cases, that ARARs or other available information be preferentially selected over risk-based PRGs as final remediation goals. As discussed in Section 4.2.2 of this Technical Memorandum, the residual radioactivity levels are based on an office worker scenario which is consistent with the RME programmatic risk-based PRGs selected for the other OU6 surface soil COCs.

The cleanup standards established at other Colorado National Priorities List (NPL) sites were considered only to verify that the selected remediation target is consistent with previously approved RODs. The selected remediation targets do not appear to be consistent with other Colorado ROD cleanup levels. As discussed in Section 4.2.4 of this Technical Memorandum, the cleanup standards established at the other Colorado sites are based on criteria that is different from that being used for developing the OU6 remediation targets. As such, the other NPL site cleanup standards were deemed to be inappropriate for comparison purposes.

All of the selected remediation targets are greater than the corresponding background concentrations and minimum analytical detection limits. As such, the selected remediation targets for OU6 surface soils are deemed to be reasonable and achievable.

4.3 Subsurface Soils

Table 4-3 presents the background concentrations, minimum analytical detection limits, potential chemical-specific ARARs/TBCs, programmatic risk-based PRGs, and cleanup standards established at other Colorado remediation sites that were considered in setting a remediation target for each OU6 subsurface soil COC. The following subsections provide additional details regarding the source and/or methods used to identify and select the remediation targets.

4.3.1 Background Concentrations

Background sampling was not conducted for organic compounds, as such, background concentrations for all organic compounds are assumed to be zero. However, it is recognized that some of the compounds detected in the subsurface soils may be the result of other human-made, non-IHSS sources.

TABLE 4-3
PRELIMINARY REMEDIATION LEVELS FOR SUBSURFACE SOIL

Subsurface Soil Chemical of Concern (Units as Indicated)	Background Concentration (UTL _{99%})	Minimum Analytical Detection Limit ^{b/}	Potential Chemical-Specific ARARs/TBCs		Programmatic Risk-Based PRG					Cleanup Standards Established at Other Colorado NPL Sites	Selected Remediation Target
					Commercial\Industrial ^{a/}						
			ARARs	TBCs	RME ^{b/}		CT ^{d/}				
					NC ^{d/}	C ^{e/}	NC ^{d/}	C ^{e/}			
Barium (mg/kg)	3 71e+02	4 00e+01	--	--	1 24e+05	--	6 21e+05	--	1 00e+02 ^{v/}	1 24e+05	
Benzo(a)pyrene (mg/kg)	0 00e+00 ^{u/}	3 30e-01	--	--	--	1 70e+01	--	8 59e+01	8 20e+00 ^{v/}	1 70e+01	
Benzo(b)fluoranthene (mg/kg)	0 00e+00 ^{u/}	3 30e-01	--	--	--	1 70e+02	--	8 59e+02	--	1 70e+02	
Methylene Chloride (mg/kg)	0 00e+00 ^{u/}	5 00e-03	--	--	1 06e+05	1 66e+04	5 38e+05	8 36e+04	7 50e-02 ^{b/}	1 66e+04	
Americium-241 (pCi/g)	2 00e-02	2 00e-02	--	7 95e+02 ^{v/}	--	2 16e+02	--	5 37e+02	--	7 95e+02	
Plutonium-239/240 (pCi/g)	3 00e-02	3 00e-02	--	1 57e+03 ^{v/}	--	3 01e+02	--	1 51e+03	--	1 57e+03	
Uranium-233/234 (pCi/g) ^{u/}	3 44e+00	3 00e-01	--	4 93e+04 ^{v/}	--	4 13e+03	--	1 75e+04	--	4 93e+04	
Uranium-238 (pCi/g) ^{u/}	1 81e+00	3 00e-01	--	3 93e+03 ^{v/}	--	7 98e+01	--	8 13e+01	--	3 93e+03	

NOTES

^{u/} Commercial/Industrial exposure is based on a construction worker scenario

^{b/} PRGs are based on Reasonable Maximum Exposure factors

^{c/} PRGs are based on Central Tenancy Exposure factors

^{d/} PRGs are based on non-carcinogenic toxicity information

^{e/} PRGs are based on carcinogenic toxicity information

^{f/} Background concentrations for organic compounds are assumed to be zero

^{g/} SOURCE Martin Marietta, Denver, Aerospace (EPA/ROD/R08-90/035) Cleanup standard for barium is provided as mg/L and is based on a LDR treatment standard which is applied to the TCLP extract from the treated waste Cleanup standard for benzo(a)pyrene is the LDR treatment standard for U022 which is based incineration as the BAT

^{h/} SOURCE Sand Creek Industrial (EPA/ROD/R08-89/024) Cleanup standard is based on protection of groundwater resulting from the migration of soil contaminants

^{i/} PRG values include daughter products

^{j/} TBC value based on RME exposure factors at a 100 mrem per year effective dose equivalent for the construction worker exposure scenario

^{k/} Minimum analytical detection limits originate from the General Radiochemistry and Routine Analytical Services Protocol (EG&G, 1991, and EG&G 1991a)

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-12
February, 1995	Organization	ER OU 5, 6, & 7 Closures

4.3.2 Potential Chemical-Specific ARARs/TBCs

Federal or State chemical-specific ARARs were not identified as potential remediation targets for the OU6 subsurface soil COCs. For radionuclides, DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, (DOE, 1990) is considered a TBC for establishing residual radioactivity levels in subsurface soils. The concentrations presented in Table 4-3 in the TBC column for the radionuclides (americium-241 and plutonium-239/240) equate to an individual effective dose equivalent of 100 mrem per year based on the construction worker exposure scenario. The contribution of multiple radionuclides to the effective dose equivalent for this exposure scenario will be addressed before the final remediation goals are established. The provisions of DOE Order 5400.5 are currently in the process of being promulgated as 10 CFR 834. Once promulgated, the dose limit of 100 mrem will be considered an ARAR.

NRC standards for radionuclides are not considered to be potential ARARs at RFETS. NRC standards are not applicable since DOE is exempt from NRC regulations. Furthermore, NRC standards are not considered to be appropriate since the DOE required to and has established radiation protection standards for offsite members of the public pursuant to DOE Order 5400.5 which is currently in the process of being promulgated as 10 CFR 834.

4.3.3 Programmatic Risk-Based Preliminary Remediation Goals

The potential future receptor considered for calculating the programmatic risk-based PRGs for subsurface soil was construction workers assuming that the primary risk is due to direct ingestion of soils, inhalation of particulates, inhalation of VOCs and external exposure to radiation. Risk-based PRGs for the gravel mine worker exposure scenario are not presented because the feasibility of mining OU6 for commercial purposes is not considered viable (EG&G, 1994). Review of the boring logs indicates this exposure scenario is inappropriate for OU6 due to the limited presence of exploitable quantities of minable materials. Should gravel mining be identified as a viable future land-use option for OU6, the remediation targets and remedial alternatives will be revised accordingly.

4.3.4 Cleanup Standards at Other Colorado Sites

Two RODs for CERCLA sites located in Colorado were identified that contained at least one of the OU6 subsurface soil COCs: the Sand Creek Industrial Site and the Martin Marietta Denver, Aerospace Site. It was determined that cleanup standards for surface and subsurface soils were not routinely separated. As such, comparing the cleanup values from the RODs for soils contained in Table 4-3 against the programmatic risk-based PRGs calculated specifically for subsurface soils may not be appropriate.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-13
February, 1995	Organization	ER OU 5, 6, & 7 Closures

The 1989 ROD for the Sand Creek Industrial Site included an action level for methylene chloride in soil based on the results of a soil-water leaching model and carcinogenic risk of 10^{-6} for ingestion of groundwater. As such, the methylene chloride action level is not directly comparable to the programmatic risk-based PRGs listed in Table 4-3 since the programmatic exposure scenarios do not include pathways to evaluate the migration of vadose zone contamination to groundwater.

The 1990 ROD for the Martin Marietta, Denver, Aerospace Site contained action levels for barium and benzo(a)pyrene, based upon RCRA Toxicity Characteristic determination and background concentrations. The cleanup standard for barium and benzo(a)pyrene presented in the Martin Marietta ROD are based on attaining the RCRA hazardous waste LDR treatment standards specified in 40 CFR 268. Since the LDR cleanup standard for barium is based on the leachate extract of the treated soils (e.g., Toxic Characteristic Leaching Procedure), it is not directly comparable to the background concentrations and corresponding programmatic risk-based PRGs (which are based on total concentrations) listed in Table 4-3. The cleanup standard for benzo(a)pyrene is based on the non-waste water LDR treatment standard for U022 as listed in the Third Third rule making dated January 31, 1991 (see 55 FR 3908). This treatment standard is given as a total concentration limit and is based on using incineration as the best available treatment technology. The 8.2 mg/kg cleanup standard was considered to be inappropriate since the cleanup standard is not based on determining the risks resulting from the exposure to this compound but rather the achievable results using a specified technology.

4.3.5 Selection of Remediation Targets for Subsurface Soils

The selected remediation targets for the OU6 subsurface soil COCs are presented on Table 4-3. The remediation targets for barium, benzo(a)pyrene, benzo(b)fluoranthene, and methylene chloride are based on the calculated programmatic risk-based PRGs for the construction worker scenario utilizing RME exposure factors. The RME programmatic risk-based PRGs were selected since corresponding ARARs/TBCs are not available for these OU6 subsurface soil COCs.

The selected remediation targets for americium-241, plutonium-239/240, uranium 233/234, and uranium-238 are based on the calculated residual radioactivity levels conforming to the 100 mrem per year radiation dose standard contained in DOE Order 5400.5. This TBC level was selected over other calculated programmatic risk-based PRGs since the NCP requires, in most cases, that ARARs or other available information be preferentially selected over risk-based PRGs as final remediation goals. As discussed in Section 4.3.2 of this Technical Memorandum, the residual radioactivity levels are based on a construction worker scenario which is consistent with the RME programmatic risk-based PRGs selected for the other OU6 subsurface soil COCs.

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Remediation Targets for OU6
Page 4-14
Organization ER OU 5, 6, & 7 Closures

The cleanup standards established at other Colorado NPL sites were considered only to verify that the selected remediation target is consistent with previously approved RODs. Although several of the selected remediation targets are greater than the published ROD cleanup standards, a direct comparison of the values is not appropriate since there was no distinction in the RODs between surface and subsurface soil and/or the ROD cleanup standards are not based on risk related exposure pathways. As such, cleanup standards established at other NPL sites were not considered to be pertinent to the OU6 remediation targets for subsurface soils.

All of the selected remediation targets are greater than the corresponding background concentrations and minimum analytical detection limits. As such, the selected remediation targets for OU6 subsurface soils are deemed to be reasonable and achievable.

4.4 Sediments

Tables 4-4 and 4-5 present the background concentrations, minimum analytical detection limits, potential chemical-specific ARARs/TBCs, OU-specific risk-based PRGs, and cleanup standards established at other Colorado remediation sites that were considered in setting remediation targets for the OU6 pond sediment and stream sediment COCs. The following subsections provide additional details regarding the source and/or methods used to identify and select the remediation targets.

4.4.1 Background Concentrations

Seep and spring background data were used for comparison to pond sediments, because of the similarity in flow regime and residence time between seeps and ponds. For stream sediment, background data from stream beds were used. The background concentration for Aroclor-1254 in sediments was assumed to be zero since PCBs were not part of the background characterization effort.

4.4.2 Potential Chemical-Specific ARARs/TBCs

Federal and State chemical-specific ARARs/TBCs were not identified for the OU6 pond and stream sediment COCs with the exception of PCBs and radionuclides. The management and disposal of PCB waste is regulated under the Toxic Substances Control Act (TSCA). The TSCA requirements for cleaning up PCB contaminated soils are presented in 40 CFR 761, Subpart G which is entitled *PCB Spill Cleanup Policy*. This policy establishes cleanup criteria for spills that occurred after May 4, 1987. DOE considers the *PCB Spill Cleanup Policy* a TBC for establishing remediation targets that are protective of human health and the environment at OU6. The Policy

TABLE 4-4
PRELIMINARY REMEDIATION LEVELS FOR POND SEDIMENT

Pond Sediment Chemical of Concern (Units as Indicated)	Background Concentration (UTL _{99%})	Minimum Analytical Detection Limit ^v	Potential Chemical-Specific ARARs/TBCs		OU-Specific Risk-Based PRG						Cleanup Standards Established at Other Colorado NPL Sites	Selected Remediation Target
					Residential ^u			CT ^d				
			ARARs	TBCs	RME ^{b/}		NC ^{d/}	C ^{d/}	NC ^{d/}	C ^{d/}		
					NC ^{d/}	C ^{d/}						
Antimony (mg/kg)	5 50e+01	1 20e+01	--	--	2 92e+04	--	2 92e+04	--	--	--	2 92e+04	
Aroclor-1254 (mg/kg)	0 00e+00 ^u	4 40e-02	--	1 00e+01 ^{u/}	--	2 21e+01	--	7 37e+01	--	--	1 00e+01	
Benzo(a)pyrene (mg/kg)	0 00e+00 ^u	3 30e-01	--	--	--	2 33e+01	--	7 78e+01	--	--	2 33e+01	
Benzo(b)fluoranthene (mg/kg)	0 00e+00 ^u	3 30e-01	--	--	--	2 33e+02	--	7 78e+02	--	--	2 33e+02	
Bis(2-ethylhexyl)phthalate (mg/kg)	0 00e+00 ^u	3 30e-01	--	--	> 1 00e+06	1 22e+04	> 1 00e+06	4 06e+04	--	--	1 22e+04	
Silver (mg/kg)	1 15e+01	2 00e+00	--	--	3 65e+05	--	3 65e+05	--	--	--	3 65e+05	
Vanadium (mg/kg)	8 30e+01	1 00e+01	--	--	5 11e+05	--	5 11e+05	--	--	--	5 11e+05	
Zinc (mg/kg)	1 43e+02	4 00e+00	--	--	> 1 00e+06	--	> 1 00e+06	--	--	--	1 00e+06	
Americium-241 (pCi/g)	1 47e+00	2 00e-02	--	1 60e+03 ^{u/}	--	8 32e+00	--	5 78e+01	--	--	1 60e+03	
Plutonium-239/240 (pCi/g)	7 68e+00	3 00e-02	--	3 15e+04 ^{u/}	--	3 26e+02	--	1 22e+03	--	--	3 15e+04	

NOTES

- ^{u/} Residential exposure for sediments is based on recreational use
- ^{b/} PRGs are based on Reasonable Maximum Exposure factors
- ^{d/} PRGs are based on Central Tendency Exposure factors
- ^{u/} PRGs are based on non-carcinogenic toxicity information
- ^{d/} PRGs are based on carcinogenic toxicity information
- ^{u/} Background concentrations for organic compounds are assumed to be zero
- ^{u/} TBC value based on EPA's PCB Spill Cleanup Policy [see 40 CFR 761.120 and 761.125]
- ^{b/} TBC value based on RME exposure factors at a 100 mrem per year effective dose equivalent for the recreational residential exposure scenario
- ^{v/} Minimum analytical detection limits originate from the General Radiochemistry and Routine Analytical Services Protocol (EG&G, 1991, and EG&G 1991a)

TABLE 4-5
PRELIMINARY REMEDIATION LEVELS FOR STREAM SEDIMENT

Stream Sediment Chemical of Concern (Units as Indicated)	Background Concentration (UTL _{99%})	Minimum Analytical Detection Limit ^{b/}	Potential Chemical-Specific ARARs/TBCs		OU-Specific Risk-Based PRG						Cleanup Standards Established at Other Colorado NPL Sites	Selected Remediation Target
					Residential ^{a/}			CT ^{d/}				
			ARARs	TBCs	RME ^{b/}		NC ^{d/}	C ^{e/}	NC ^{d/}	C ^{e/}		
					NC ^{d/}	C ^{e/}						
Benzo(a)anthracene (mg/kg)	0 00e+00 ^{h/}	3 30e-01	--	--	--	2 33e+02	--	--	7 78e+02	--	2 33e+02	
Benzo(a)pyrene (mg/kg)	0 00e+00 ^{h/}	3 30e-01	--	--	--	2 33e+01	--	--	7 78e+01	--	2 33e+01	
Benzo(b)fluoranthene (mg/kg)	0 00e+00 ^{h/}	3 30e-01	--	--	--	2 33e+02	--	--	7 78e+02	--	2 33e+02	
Cobalt (mg/kg)	1 93e+01	1 00e+01	--	--	> 1 00e+06	--	--	> 1 00e+06	--	--	1 00e+06	
Indeno(1,2,3-cd)pyrene (mg/kg)	0 00e+00 ^{h/}	3 30e-01	--	--	--	2 33e+02	--	--	7 78e+02	--	2 33e+02	
Strontium (mg/kg)	2 95e+02	4 00e+01	--	--	> 1 00e+06	--	--	> 1 00e+06	--	--	1 00e+06	
Vanadium (mg/kg)	6 34e+01	1 00e+01	--	--	5 11e+05	--	--	5 11e+05	--	--	5 11e+05	
Zinc (mg/kg)	8 08e+02	4 00e+00	--	--	> 1 00e+06	--	--	> 1 00e+06	--	--	1 00e+06	
Americium-241 (pCi/g)	1 77e+00	2 00e-02	--	1 60e+03 ^{g/}	--	8 32e+00	--	--	5 78e+01	--	1 60e+03	
Plutonium-239/240 (pCi/g)	5 66e+00	3 00e-02	--	3 15e+04 ^{g/}	--	3 26e+02	--	--	1 22e+03	--	3 15e+04	

NOTES

^{a/} Residential exposure for sediments is based on recreational use

^{b/} PRGs are based on Reasonable Maximum Exposure factors

^{c/} PRGs are based on Central Tendency Exposure factors

^{d/} PPGs are based on non-carcinogenic toxicity information

^{e/} PRGs are based on carcinogenic toxicity information

^{f/} Background concentrations for organic compounds are assumed to be zero

^{g/} TBC value based on RME exposure factors at a 100 mrem per year effective dose equivalent for the recreational residential exposure scenario

^{h/} Minimum analytical detection limits originate from the General Radiochemistry and Routine Analytical Services Protocol (EG&G, 1991, and EG&G 1991a)

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-17
February, 1995	Organization	ER OU 5, 6, & 7 Closures

states that spills involving 1 pound or more PCBs by weight in non-restricted areas to be remediated to 10 ppm PCBs by weight [See 40 CFR 761 125(c)(4)(v)]

For radionuclides, DOE Order 5400 5, *Radiation Protection of the Public and the Environment*, (DOE, 1990) is considered a TBC for establishing residual radioactivity levels in sediments. This DOE Order restricts the offsite radiation dose to members of the public to 100 mrem effective dose equivalent per year. The OU-specific PRG equations for the residential recreational use of the ponds (see Section 4.4.3) and the RME exposure factors were used to calculate residual radionuclide concentrations in sediments. The concentrations presented in Table 4-2 in the TBC column for the radionuclides (americium-241 and plutonium-239/240) equate to an individual effective dose equivalent of 100 mrem per year to an exposed resident. The contribution of multiple radionuclides to the effective dose equivalent for a specific exposure scenario will be addressed before the final remediation goals are established. The provisions of DOE Order 5400 5 are currently in the process of being promulgated as 10 CFR 834. The annual effective dose limit of 100 mrem is considered a TBC until promulgation of 10 CFR 834, at which time this dose limit will be considered an ARAR.

NRC standards for radionuclides are not considered to be potential ARARs at RFETS. NRC standards are not applicable since DOE is exempt from NRC regulations. Furthermore, NRC standards are not considered to be appropriate since the DOE required to and has established radiation protection standards for offsite members of the public pursuant to DOE Order 5400 5 which is currently in the process of being promulgated as 10 CFR 834.

4.4.3 OU-Specific Risk-Based Preliminary Remediation Goals

Exposure to sediments was not considered in the development of the programmatic risk-based PRGs for the RFETS. As such, an OU-specific exposure scenario was established. It is assumed that the ponds will remain intact and may be used by residents for recreational purposes. The exposure pathways considered for the hypothetical exposure scenario includes direct ingestion of sediment, inhalation of contaminated particulates, and external radiation dose. The equations presented in Appendix D were used, in conjunction with the exposure factors and the chemical-specific toxicity information presented in Appendices B and C, to calculate the RME and CT PRGs for the pond and stream sediments presented in Tables 4-4 and 4-5. Several of the programmatic risk-based PRGs calculated for bis(2-ethylhexyl)phthalate, cobalt, strontium, and zinc exceeded the saturation limit (e.g., greater than 100% by weight in the sediment matrix). As such, these programmatic risk-based PRG values are reported as "> 1.00e+06" in Tables 4-4 and 4-5.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-18
February, 1995	Organization	ER OU 5, 6, & 7 Closures

4.4.4 Cleanup Standards at Other Colorado Sites

Results of the RODs database search indicate that no Colorado RODs contained cleanup standards for the OU6 sediment COCs

4.4.5 Selection of Remediation Targets for Sediments

The selected remediation targets for the OU6 pond and stream sediment COCs are presented on Tables 4-4 and 4-5, respectively. The remediation targets for all of the sediment COCs, except for Aroclor-1254 and the radionuclides are based on the calculated OU-specific PRGs for residential recreational use scenario utilizing RME exposure factors. The RME PRGs were selected since corresponding ARARs/TBCs are not available for these OU6 surface soil COCs.

The cleanup criteria established in 40 CFR 761 for PCBs (e.g., 25 ppm) was selected as the remediation target for Aroclor-1254 in pond sediment because the standard is a widely accepted TBC for the cleanup of PCB spills. It is also noted that the RME PRG calculated for the sediment exposure pathway is almost identical to the selected 25 ppm remediation target.

The selected remediation targets for americium-241 and plutonium-239/240 are based on the calculated residual radioactivity levels conforming to the 100 mrem per year radiation dose standard contained in DOE Order 5400.5. This TBC level was selected over other calculated OU-specific PRGs since the NCP requires, in most cases, that ARARs or other available information be preferentially selected over risk-based PRGs as final remediation goals. As discussed in Section 4.4.2 of this Technical Memorandum, the residual radioactivity levels are based on a residential recreational use scenario which is consistent with the RME OU-specific PRGs selected for the other OU6 sediment COCs.

All of the selected remediation targets are greater than the corresponding background concentrations and minimum analytical detection limits. As such, the selected remediation targets for OU6 sediments are deemed to be reasonable and achievable.

4.5 Groundwater

Table 4-6 presents the background concentrations, minimum analytical detection limits, potential chemical-specific ARARs/TBCs, programmatic risk-based PRGs, and cleanup standards established at other Colorado remediation sites that were considered in setting the remediation targets for the OU6 groundwater COCs. The following subsections provide additional details regarding the source and/or methods used to identify and select the remediation targets.

TABLE 4-6
PRELIMINARY REMEDIATION LEVELS FOR GROUNDWATER

Groundwater Chemical of Concern (Units as Indicated)	Background Concentration (UTL 99%)	Minimum Analytical Detection Limit ^{a/}	Potential Chemical-Specific ARARs/TBCs		Programmatic Risk-Based PRGs						Cleanup Standards Established at Other Colorado NPL Sites	Selected Remediation Target
					Residential ^{u/}			CT ^{d/}				
			ARARs	TBCs	RME ^{b/}			C ^{e/}				
					NC ^{d/}	C ^{e/}	NC ^{d/}	NC ^{d/}	C ^{e/}			
Chloroform (µg/L)	0 00e+00 ^{u/}	5 00e+00	6 00e+00 ^{b/} <1 00e+02 ^{u/}	--	3 65e+02	2 76e-01	5 45e+02	1 52e+00	1 00e+02 ^{u/}	1 00e+02	1 00e+02	
Methylene Chloride (µg/L)	0 00e+00 ^{u/}	5 00e+00	5 00e+00 ^{b/}	--	1 73e+03	6 22e+00	2 64e+03	3 23e+01	1 00e+01 ^{m/}	5 00e+00	5 00e+00	
Nitrate (mg/L)	5 11e+03	5 00e+00	1 00e+01 ^{u/}	--	5 84e+01	--	8 72e+01	--	1 00e+01 ^{b/}	1 00e+01	1 00e+01	
Tetrachloroethene (µg/L)	0 00e+00 ^{u/}	5 00e+00	5 00e+00 ^{b/}	--	3 65e+02	1 43e+00	5 45e+02	7 16e+00	1 00e+01 ^{u/} 5 00e+00 ^{m/}	5 00e+00	5 00e+00	
Trichloroethene (µg/L)	0 00e+00 ^{u/}	5 00e+00	5 00e+00 ^{b/}	--	--	2 55e+00	--	1 36e+01	5 00e+00 ^{k/}	5 00e+00	5 00e+00	
Vinyl Chloride (µg/L)	0 00e+00 ^{u/}	1 00e+01	2 00e+00 ^{b/}	--	--	2 81e-02	--	1 45e-01	2 00e+00 ^{b/}	2 00e+00	2 00e+00	
Americium-241 (pCi/L)	3 70e-02 ^{g/}	1 00e-02	--	3 00e+01 ^{u/}	--	1 98e-01	--	9 87e-01	--	3 00e+01	3 00e+01	
Plutonium-239/240 (pCi/L)	6 40e-02	1 00e-02	--	3 00e+01 ^{u/}	--	2 07e-01	--	1 03e+00	--	3 00e+01	3 00e+01	
Radium-226 (pCi/L)	1 30e+00	5 00e-01	--	1 00e+02 ^{u/}	--	3 97e-01	--	1 97e+00	--	1 00e+02	1 00e+02	

NOTES.

^{a/} PRGs are based on domestic use for a residential exposure scenario

^{b/} PRGs are based on Reasonable Maximum Exposure factors

^{c/} PRGs are based on Central Tendency Exposure factors

^{d/} PRGs are based on non-carcinogenic toxicity information

^{e/} PRGs are based on carcinogenic toxicity information

^{f/} Background concentrations for organic compounds are assumed to be zero

^{g/} Background concentration is based on total americium, not isotope specific

^{h/} ARAR standard is based on Colorado Statewide Standard for Ground Water (5 CCR 1002-8, Section 3 11)

^{i/} ARAR standard is based on Maximum Contaminant Levels (40 CFR 141 and 142) Value for chloroform is based on the sum of all trihalomethanes

(1 e bromodichloromethane, dibromochloromethane, bromoform, and chloroform)

^{j/} Derived concentration guidelines from DOE Order 5400 5, Chapter III, based on 100 mrem radiation dose

^{k/} Martin Marietta, Denver, Aerospace (EPA/ROD/R08-90/035)

^{l/} Rocky Mountain Arsenal - OU17 (EPA/ROD/R08-90/037)

^{m/} Chemical Sales - OU1 (EPA/ROD/R08-91/045) and/or OU2 (EPA/ROD/R08-91/046)

^{n/} Minimum analytical detection limits originate from the General Radiochemistry and Routine Analytical Services Protocol (EG&G, 1991, and EG&G 1991a)

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-20
February, 1995	Organization	ER OU 5, 6, & 7 Closures

4.5.1 Background Concentrations

Results for unfiltered background samples are presented because these are considered to be the most representative for potential exposures. Background concentrations for VOCs were assumed to be zero. The background level presented in Table 4-6 for nitrate is a calculated value based on subtracting the measured background concentration for nitrite (149 $\mu\text{g/L}$) from the measured background concentration for total nitrate-nitrite (5,261 $\mu\text{g/L}$).

4.5.2 Potential Chemical-Specific ARARs/TBCs

As required by the NCP, there are several regulations and other guidance documents that are typically considered when selecting remediation targets for groundwater. The NCP states that Maximum Contaminant Levels (MCLs) and non-zero Maximum Contaminant Level Goals (MCLGs) are to be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water [See 40 CFR 300.430(e)(2)(i)(B)]. The NCP also states that water quality criteria established under Sections 303 or 304 of the Clean Water Act qualify as PRGs only when they are determined to be relevant and appropriate to the circumstance of the release [See 40 CFR 300.430(e)(2)(i)(E)]. Although these standards are not directly applicable to the remediation of groundwater, the NCP requires they be considered as to whether they are relevant and appropriate. As such, Federal MCLs and non-zero MCLGs, State drinking water standards, and Federal and State water quality criteria were determined to be potential ARARs/TBCs, except standards for Atomic Energy Act (AEA) regulated radionuclides. With regards to standards for radionuclides, DOE radiation protection requirements were determined to be TBCs. The Federal and State chemical-specific ARARs/TBCs that were considered for selecting the remediation targets for OU6 are identified in Appendix E and include

- Federal MCLs and non-zero MCLGs adopted under the Safe Drinking Water Act, (40 CFR 141 and 142),
- State of Colorado Primary Drinking Water Regulations (5 CCR 1003-1),
- Federal Water Quality Criteria issued by EPA pursuant to Section 303 of the Clean Water Act,
- State of Colorado groundwater quality standards (5 CCR 1002-8, Section 3.11),
- State of Colorado groundwater protection standards for hazardous waste facilities (6 CCR 1007-3, 264.94), and

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-21
February, 1995	Organization	ER OU 5, 6, & 7 Closures

- DOE Order 5400 5, *Radiation Protection of the Public and the Environment* (DOE, 1990)

The application of these standards to the remediation of groundwater beneath OU6 is discussed in the following paragraphs

Although the UHSU at OU6 may not be amenable as a suitable supply of groundwater for domestic use, Federal MCLs and non-zero MCLGs, except for AEA regulated radionuclides, were determined to be potentially relevant and appropriate. Since Colorado is authorized to implement the Federal Safe Drinking Water Act program, State drinking water regulations were also considered as potential ARARs. In order for a State standard to be designated as an ARAR, the State requirement is to be more stringent than the corresponding Federal standard. Although the State drinking water standards are identical to the Federal requirements, both Federal and State drinking water standards have been identified in Appendix E for completeness.

In addition to the drinking water standards, Sections 303 and 304 of the Clean Water Act allows EPA and States to adopt water quality standards to protect the use classification assigned to water resources. The EPA has adopted Federal Water Quality Criteria which include health based standards for the consumption of drinking water and fish. The Federal Water Quality Criteria considered is based on the May 1, 1991 table issued by EPA's Office of Science and Technology and the July 14, 1993 letter containing the updated version of the water quality criteria for EPA Region VIII. These non-promulgated standards are listed in Appendix E. None of these standards were considered to be ARARs in selecting the remediation targets for the groundwater resources at OU6 because the Federal standards are based on the consumption of both water and fish.

The Colorado Water Quality Control Commission (WQCC) has promulgated groundwater standards for all source groundwater, unclassified and classified, groundwater that has been classified for a specific existing or potential use, and site-specific standards. [See 5 CCR 1002-8, Sections 3 11 and 3 12] [See 5 CCR 1002-8, Section 3 12 7]. Despite questions regarding enforceability, the Statewide groundwater standards for groundwater that has not been classified for a specific existing or potential use will be considered potential ARARs, except for standards associated with AEA regulated radionuclides.

The Colorado WQCC has specifically classified the Quaternary and Rocky Flats aquifers beneath the RFETS as domestic use quality, agricultural use quality, and surface water protection. The Colorado WQCC has also designated site-specific groundwater standards for the RFETS [see 5 CCR 1002-8, Section 3 12 7(1)]. However, in order for the standards associated with the site-specific use classifications and the site-specific standards to be identified as ARARs, they must

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Remediation Targets for OU6
Page 4-22
Organization ER OU 5, 6, & 7 Closures

be of "general applicability" and "enforceable" [See 40 CFR 300.400(g)(4)] The RFETS site-specific groundwater use classifications, and their associated standards, and the RFETS site-specific standards [5 CCR 1002-8, Section 3.12.7(1)] are not considered ARARs because those use classifications, their associated standards, and the RFETS site-specific standards have not been generally applied to other remedial sites throughout the State. RFETS is the only industrial site in Colorado that has the State groundwater use classifications of domestic use quality, agricultural use quality, and surface water protection imposed upon it. RFETS is the only industrial site in Colorado to have site-specific standards for parameters that have probably been used at other industrial sites in Colorado. Although the Statewide and RFETS site-specific standards are listed in Appendix E, the Statewide standards associated with a use classification, and the RFETS-specific use classifications (including associated standards) and the RFETS site-specific standards are not considered to be ARARs for the remediation of groundwater at OU6.

The hazardous waste facility groundwater protection standards are not considered to be applicable since none of the OU6 IHSSs are designated hazardous waste management units. Since other, more relevant, groundwater protection ARARs have been identified for drinking water supplies (i.e., MCLs), the hazardous waste facility groundwater protection standards were not considered to be relevant and appropriate to OU6.

With respect to radionuclides, the AEA grants DOE authority over AEA regulated radionuclides. Pursuant to this authority, DOE has established radiation protection standards for offsite members of the public under DOE Order 5400.5. To ensure that the offsite radiation dose is maintained below established limits, DOE has developed Derived Concentration Guides (DCGs) for exposures via the ingestion of water based on an effective dose equivalent limit to offsite members of the public of 100 mrem per year. The DCGs were considered in selecting protective remediation targets for the OU6 groundwater. The fact that multiple radionuclides may contribute to the effective dose equivalent was not considered for the values presented in Table 4-6. The risk contributions associated with the presence of multiple radionuclides will be addressed prior to establishing final remediation goals for the groundwater at OU6. Until such time that these factors are considered, the DCGs were deemed to be an appropriate starting point for assessing the groundwater remediation needs for OU6. The provisions of DOE Order 5400.5 are currently in the process of being promulgated as 10 CFR 834. The DCGs are considered TBCs until promulgation of 10 CFR 834, at which time the DOE radiation protection requirements will be identified as ARARs.

Groundwater standards for radionuclides developed by the NRC were not considered to be ARARs. These standards are not applicable to the RFETS because the DOE is exempt from NRC regulation. The NRC standards were also determined not to be appropriate since DOE is required to and has established radiation protection standards for offsite members of the public.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-23
February, 1995	Organization	ER OU 5, 6, & 7 Closures

pursuant to DOE Order 5400 5 (which is currently in the process of being promulgated as 10 CFR 834)

4.5.3 Risk-Based Programmatic Preliminary Remediation Goals

Although the DOE Rocky Flats Field Office Future Site Use Working Group is expected to recommend onsite residential use should be eliminated from the future land use plan (see meeting minutes dated 12/8/94), the programmatic risk-based PRGs considered in the selection of remediation targets for the OU6 groundwater is based on the residential use scenario to be consistent with the previously developed programmatic pathways. It is also noted that the groundwater supply may not be amendable for domestic use. The equations and exposure factors used to calculate the groundwater programmatic risk-based PRGs are consistent with EPA guidance entitled *Human Health Evaluation Manual, Part B Development of Risk-Based Preliminary Remediation Goals* (EPA, 1991). The calculation of groundwater programmatic risk-based PRGs using the residential land use scenario assumes the primary risk is due to direct ingestion of groundwater and the inhalation of VOCs from household groundwater use.

4.5.4 Cleanup Standards at Other Colorado Sites

Five RODs for CERCLA sites located in Colorado were identified that contained at least one of the OU6 groundwater COCs. These ROD cleanup standards are associated with the following sites:

- Marshall Landfill,
- Martin Marietta, Denver Aerospace,
- Rocky Mountain Arsenal - OU17,
- Chemical Sales - OU1, and
- Chemical Sales - OU2

The 1986 ROD for Marshall Landfill specified a groundwater cleanup standard for tetrachloroethene and trichloroethene of zero. The 1986 Marshall Landfill ROD was not included on Table 4-6 for comparison purposes because it is neither possible to technically achieve nor to demonstrate compliance with a cleanup standard of zero.

The 1990 ROD for the Martin Marietta, Denver Aerospace Site includes action levels for nitrate, trichloroethene, and vinyl chloride are based on MCLs and MCLGs.

The 1990 ROD for the Rocky Mountain Arsenal - OU17 Site includes action levels for chloroform and tetrachloroethene in groundwater are based on MCLs.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-24
February, 1995	Organization	ER OU 5, 6, & 7 Closures

The 1991 RODs for the Chemical Sales - OU1 and OU2 sites include action levels for methylene chloride, tetrachloroethene, and trichloroethene are based primarily on MCLs

4.5.5 Selection of Remediation Targets for Groundwater

As discussed in Section 4.1 and pursuant to the NCP, the remediation targets were selected based on readily available information, such as the chemical-specific ARARs and TBCs. Chemical-specific ARARs and TBCs were selected over other calculated risk-based PRGs since the NCP requires, in most cases, that ARARs or other available information be preferentially selected over risk-based PRGs as final remediation goals. In addition to being established using risk-based factors, technical feasibility and cost-effectiveness are also normally considered when establishing chemical-specific ARARs/TBCs, the development of risk-based PRGs do not take into account technical practicability and cost. As such, chemical-specific ARARs/TBCs are widely accepted as cleanup standards for Superfund sites. Where multiple ARARs/TBCs exist for a chemical compound, EPA's fact sheet entitled *ARARs Questions and Answers Compliance With Federal Water Quality Criteria* (EPA, 1990) was followed to determine the hierarchy of these requirements.

Although the final land use for RFETS and the ability of the UHSU aquifer to supply groundwater for domestic use are questionable, the OU6 remediation targets selected for chloroform, methylene chloride, nitrate, tetrachloroethene, trichloroethene, and vinyl chloride are all based on Federal/State MCLs that have been promulgated for the protection of drinking water. It is proposed that the selected remediation targets be applied to the protection of groundwater at the RFETS boundary in the event a non-residential final land use is established for RFETS or the UHSU is determined to be unsuitable as a drinking water supply. The MCL standards were also determined to be protective of surface waters that may be hydraulically connected to the groundwater.

With respect to chloroform, the selected remediation target is based on the 100 µg/L Federal MCL for total trihalomethanes. This Federal MCL was chosen over other potential chemical-specific ARARs for the following reasons:

- The Federal MCL for trihalomethanes was adopted by the Colorado WQCC for the protection and consumption of drinking water. The MCL standard, not the Colorado groundwater quality standard, is the legally enforceable limit for the supply of drinking water. Therefore, remediating groundwater to a more stringent level is considered to be neither relevant nor appropriate.

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Remediation Targets for OU6
Page 4-25
Organization ER OU 5, 6, & 7 Closures

- This standard is based on technical factors and other limitations, as such, the Federal MCL is technically achievable
- The Federal MCL has been adopted as the cleanup standard at other NPL within the State of Colorado
- Since other trihalomethanes were not identified as OU6 groundwater COCs, the maximum allowable level (100 $\mu\text{g/L}$) was assigned to chloroform

The remediation targets selected for the radionuclides (e g , americium-241, plutonium-239/240, and radium-226) are based on the DCGs provided in DOE Order 5400 5 which are considered to be TBCs The DCGs were chosen over other potential standards and risk-based PRGs since DOE has been delegated responsibility for protecting workers and the public from radiation for AEA regulated radionuclides

All of the selected remediation targets are greater than the corresponding background concentrations and minimum analytical detection limits As such, the selected remediation targets for OU6 groundwater are deemed to be reasonable and achievable for the purpose of developing remedial alternatives

4.6 Surface Water

Table 4-7 presents the background concentrations, minimum analytical detection limits, potential chemical-specific ARARs/TBCs, programmatic risk-based PRGs, and cleanup standards established at other Colorado remediation sites that were considered in setting the remediation targets for the OU6 surface water COCs The following subsections provide additional details regarding the source and/or methods used to identify and select the remediation targets

4.6.1 Background Concentrations

All of the OU6 surface water COCs are VOCs Since background sampling was not conducted for VOCs, their background concentrations were assumed to be zero

4.6.2 Potential Chemical-Specific ARARs/TBCs

As discussed in Section 4 5 2, the NCP states that MCLs and non-zero MCLGs are to be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water [See 40 CFR 300 430(e)(2)(i)(B)] The NCP also states that water quality criteria established under Sections 303 or 304 of the Clean Water Act qualify as PRGs only when they

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-27
February, 1995	Organization	ER OU 5, 6, & 7 Closures

are determined to be relevant and appropriate to the circumstance of the release [See 40 CFR 300.430(e)(2)(i)(E)] Although these standards are not directly applicable to the remediation of surface water, the NCP requires they be considered as to whether they are relevant and appropriate As such, Federal MCLs and non-zero MCLGs, State drinking water standards, and Federal and State water quality criteria were determined to be potentially relevant and appropriate Federal and State chemical-specific ARARs/TBCs that were considered for selecting the remediation targets for OU6 are identified in Appendix E and include

- State of Colorado surface water quality standards (5 CCR 1002-8, Sections 3.1.11 and 3.8),
- Federal MCLs and non-zero MCLGs adopted under the Safe Drinking Water Act, (40 CFR 141 and 142),
- State of Colorado Primary Drinking Water Regulations (5 CCR 1003-1), and
- Federal Water Quality Criteria issued by EPA pursuant to Section 303 of the Clean Water Act

Other ARARs/TBCs which provide standards for radiation protection were not considered since none of the surface water COCs are radionuclides The application of these standards to the remediation of OU6 surface water is discussed in the following paragraphs

In addition to the Statewide surface water quality standards identified in 5 CCR 1002-8, Section 3.1.11, the Colorado WQCC has promulgated site-specific use classifications and surface water quality standards for Walnut Creek The two segments of Walnut Creek which are pertinent to OU6 are Segments 4 and 5 Segment 4 consists of the mainstream and all tributaries of Walnut Creek from sources to Great Western Reservoir except for specific listings in Segment 5 Segment 5 consists of the mainstream of North and South Walnut Creeks, including all tributaries, lakes and reservoirs, from their sources to the outlets of Ponds A-4 and B-5 Both of these segments are classified as warm aquatic life class 2, recreational class 2, drinking water supply, and agricultural water supply [see 5 CCR 1002-8, Section 3.8]

The Statewide and site-specific surface water quality standards are listed in Appendix E and were considered in selecting the remediation targets for the OU6 surface waters Although Segments 4 and 5 are classified as warm aquatic life class 2 resource, there is no evidence that these segments of the drainage basin are used for fishing purposes As such, water quality standards which are based on the protection of aquatic life and/or the consumption of fish, which includes the RFETS site-specific Segment 4 and 5 standards, were not considered to be ARARs

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-28
February, 1995	Organization	ER OU 5, 6, & 7 Closures

Should the ERA determine that special ecological resources need to be protected for potential exposure to surface water contaminants, these special concerns will be appropriately considered prior to making a final remedial decision. The temporary standard for trichloroethene of 66 µg/L was eliminated as an ARAR since this temporary standard is to expire on April 1, 1996 and would not be consistent with the long-term effectiveness goals specified in the NCP.

Although the potential chemical-specific ARARs listed in Table 4-7 are based on the surface water as being a potential source of drinking water, the surface water that currently flows into the A and B-Series ponds is diverted along the Great Western Reservoir via pumping. As such, the drinking water classification for the pond water may be overly conservative with respect to developing remedial alternatives. DOE also plans to replace the temporary diversion system with a permanent system to divert surface water from RFETS so that they will no longer flow into, or have the potential to flow into, immediate downstream drinking water supplies. When these permanent structures are in place, DOE intends to file a petition with the Colorado WQCC to change the existing use classifications. For the purpose of assessing the need to remediate OU6 surface waters, using water quality surfaces that have been adopted for protecting domestic water supplies was considered to be a conservative approach. As such, the Statewide surface water quality standards for domestic use (see 5 CCR 1002-8, Section 3 1 11) were considered to be potential chemical-specific ARARs. The plans for a permanent diversion system will be considered as a potential remedial alternative to meet these ARAR standards.

As provided in 5 CCR 1002-8, Sections 3 1 11 and 3 1 14, the Statewide surface water quality standards are to be integrated into effluent discharge permits to ensure that the classified use of the surface water is adequately protected. Specifically, Section 3 1 11 states, "All surface waters of the State are subject to the [Statewide] basic standards, however, discharge of substances regulated by permits which are within those permit limitations shall not be a basis for enforcement proceeding." DOE is authorized by the EPA to discharge from the RFETS under conditions and limitations presented in the National Pollutant Discharge Elimination System (NPDES) Permit Number CO-0001333. The NPDES permit was evaluated to determine whether the discharge limitations specified for the outfalls from Pond A-3 (Outfall #002), Pond A-4 (Outfall #005), Pond B-3 (Outfall #001), and Pond B-5 (Outfall #006) should be considered in selecting the remediation targets. Since effluent limitations for the OU6 surface water COCs are not specified in the permit, the NPDES permit was not considered in selecting the remediation targets for OU6 surface water.

In addition to the Colorado surface water quality standards, Federal MCLs and non-zero MCLGs, Colorado drinking water standards were determined to be potentially relevant and appropriate for protecting surface waters that are potential sources of drinking water. Although the State drinking water standards are identical to the Federal requirements, both Federal and State drinking water standards have been identified in Appendix E for completeness. As discussed

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-29
February, 1995	Organization	ER OU 5, 6, & 7 Closures

above, the use of MCLs as remediation targets is considered to be overly conservative since surface water from the RFETS is currently being diverted around the Great Western Reservoir

Federal Water Quality Criteria also include health based standards for the consumption of drinking water and fish. The Federal Water Quality Criteria considered is based on the May 1, 1991 table issued by EPA's Office of Science and Technology and the July 14, 1993 letter containing the updated version of the water quality criteria for EPA Region VIII. These non-promulgated standards are listed in Appendix E. None of these standards were considered to be ARARs in selecting the remediation targets for the groundwater resources at OU6 because the Federal standards are based on the consumption of both water and fish.

4.6.3 Programmatic Risk-Based Preliminary Remediation Goals

The surface water programmatic risk-based PRGs were determined using standard exposure assumptions for residential and ecological worker exposure scenarios. The calculation of surface water programmatic risk-based PRGs using the residential land use scenario assumes the primary risk is due to direct ingestion of surface water containing organic contaminants while swimming. Programmatic risk-based PRGs are presented under the ecological researcher exposure scenario which assumes the primary risk is due to direct ingestion of organics while wading. Since the list of potential chemical-specific ARARs/TBCs were conservatively based on the use of the surface water as a drinking water source, the programmatic surface water exposure pathways were deemed to be inappropriate. As such, the programmatic risk-based PRGs that were calculated for the residential domestic use were also considered in the selecting remediation targets for the OU6 surface water.

Although the remediation targets are based on ARARs/TBCs and risk-based PRGs for domestic use, the programmatic risk-based PRGs which are based on a less stringent exposure involving the recreational use of the surface water resources by residents and ecological researchers could still be appropriate cleanup standards when permanent structures are in place so that surface water from the RFETS will no longer flow into, or have the potential to flow into, immediate downstream drinking water supplies. The diversion of surface water is considered a viable remedial alternative which will be addressed as part of the CMS/FS.

4.6.4 Cleanup Standards at Other Colorado Sites

Results of the RODS database search indicate that no Colorado RODs contained cleanup standards for OU6 surface water COCs.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Remediation Targets for OU6
Revision B - Draft	Page	4-30
February, 1995	Organization	ER OU 5, 6, & 7 Closures

4.6.5 Selection of Remediation Targets for Surface Water

As discussed in Section 4.1 and pursuant to the NCP, the remediation targets for surface water were selected based on readily available information, such as the chemical-specific ARARs and TBCs. Chemical-specific ARARs and TBCs were selected over other calculated risk-based PRGs since the NCP requires, in most cases, that ARARs or other available information be preferentially selected over risk-based PRGs as final remediation goals.

Where multiple ARARs/TBCs exist for a chemical compound, EPA's fact sheet entitled *ARARs Questions and Answers: Compliance With Federal Water Quality Criteria* (EPA, 1990) was followed to determine the hierarchy of these requirements. It is also noted that 5 CCR 1002-8, Section 3.1.11(5) allows an agency responsible for implementing CERCLA to select a remedial action that is more or less stringent than would be achieved by compliance with the statewide or site-specific standards where a determination is made that such a variance is authorized pursuant to the applicable provisions of CERCLA.

The OU6 remediation targets selected for 1,2-dichloroethene, methylene chloride, and trichloroethene are all based on Federal/State MCLs that have been promulgated for the protection of drinking water. These standards were selected since they were deemed to be protective of the current use classification for the surface water at the RFETS. The water quality standards for these compounds which were established for using the surface water as a drinking water supply and for the consumption of fish since there is no evidence that these segments of the drainage basin are used for fishing purposes. Furthermore, the water supply/fish consumption water quality standards are below the minimum analytical detection limits and are therefore not achievable. It is proposed that the selected remediation targets be applied to the protection of surface water at the RFETS boundary in the event that surface water diversion is eliminated as a viable option.

No ARARs/TBCs were identified for acetone, therefore, the programmatic risk-based PRG based on the residential use scenario for drinking water was selected as the remediation target.

All of the selected remediation targets are greater than the corresponding background concentrations and minimum analytical detection limits. As such, the selected remediation targets for OU6 surface water are deemed to be reasonable and achievable.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	CMS/FS Considerations
Revision B - Draft	Page	5-1
February, 1995	Organization	ER OU 5, 6, & 7 Closures

5.0 CMS/FS CONSIDERATIONS

This section presents an analysis of existing data to determine which IHSSs, environmental media, and COCs should be considered during the OU6 CMS/FS for potential remediation. The intent of this analysis is to provide a focus for the CMS/FS by reducing the number of IHSSs and environmental media required to be evaluated. The assessment of the No Further Action alternative is based on the results of two screens. The results of the first screen is documented in the Final Letter Report entitled *Colorado Department of Public Health and Environment (CDPHE) Source Area Delineation and Risk-Based Conservative Screen and EPA Areas of Concern Delineation, Human Health Risk Assessment, Walnut Creek Priority Drainage, Operable Unit No. 6* (DOE, 1994b). A summary of the CDPHE Conservative Screen is presented in Section 5.1. The second screen involved a comparison of the selected remediation targets to maximum COC concentrations detected within the OU6 IHSSs and environmental media. The results of the remediation target screen are presented in Section 5.2. Both of these screens only consider the OU6 human health COCs as the drivers for remediation. When the ERA for the Walnut Creek drainage basin is completed, environmental COCs will be considered to validate the No Further Action recommendations.

This Technical Memorandum concludes by identifying those IHSSs and environmental media for which remedial technologies will be developed and screened. These conclusions are presented in Section 5.3.

5.1 CDPHE Conservation Screen Results

The purpose of the CDPHE Conservative Screen was to scope risk assessment efforts through the identification of IHSSs that require early remedial action, IHSSs to be considered further in the risk assessment, and IHSSs or environmental media warranting No Further Action. The screen involved the comparison of conservatively estimated human health risks based on residential exposures to maximum COC concentrations. Human health risks were calculated for each environmental media on an IHSS by IHSS basis. The specific risks for each individual environmental media within the IHSS were summed to produce a IHSS-specific carcinogenic risk ratio and hazard ratio. Risk ratios below one (e.g., carcinogenic risks below 10^{-6} or hazard indices below one for noncarcinogens) indicate that the human health concerns are negligible. Although dermal exposure is considered to be an insignificant exposure pathway, it was considered as part of the human health risk calculation when the risk ratio was determined to be less than one to verify that the addition of dermal exposure would not cause the overall risk ratio to exceed one.

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	CMS/FS Considerations
Revision B - Draft	Page	5-2
February, 1995	Organization	ER OU 5, 6, & 7 Closures

Table 5-1 presents a summary of the environmental media and IHSSs that warrant further evaluation in the CMS/FS based on the results of the CDPHE Conservative Screen. A more detailed summary of the CDPHE Conservative Screen results (i.e., the numeric values for the calculated risk ratios) is provided as Appendix F. The "yes" entry in this table denotes environmental media and IHSS locations that exceed the risk ratio threshold of one. None of the IHSSs were identified as warranting early remedial action based on the calculated risks. The shaded "no" entries in Table 5-1 are the IHSSs and environmental media that are candidates for No Further Action (e.g., have a risk ratio less than one). The shaded "--" entries indicate those IHSS media that were not included as part of the RFI/RI sampling work plan since there is no reason to suspect that these IHSS media are contaminated.

The recommendations summarized below originate from the CDPHE Conservative Screen and specifically apply to the development of the CMS/FS. Because risk to human health is assumed to drive remediation, the No Further Action recommendations presented in the CDPHE Conservative Screen are being adopted for this Technical Memorandum. In addition to the No Further Action recommendations, the administrative transfer of some of the IHSSs to other OUs to more effectively assess potential risks was also considered as part of the CDPHE Conservative Screen.

The Old Outfall (IHSS 143) is located in the industrial portion of the plant. Since IHSS 143 is remote from other OU6 IHSSs, IHSS 143 is proposed to be transferred to OU8, which includes IHSSs in the industrial area.

The East Area Spray Field (IHSS 216.1) is a candidate for No Further Action based on negligible risk (ratio sum less than one) that could result from potential exposure to the soil COCs. The added potential risk from dermal exposure was found to be insignificant.

The risk ratios for soil or sediment at numerous IHSSs were less than one, thus indicating that No Further Action is required. The added potential risk from dermal exposure was found to be insignificant. These IHSSs include:

- Trenches A, B, and C (IHSSs 166.1 through 166.3),
- South Area Spray Field (F167.3),
- Pond A-4 (IHSS 142.4),
- Pond B-5 (IHSS 142.9), and
- Walnut and Indiana Pond (IHSS 142.12)

With respect to groundwater, the CDPHE Conservative Screen concludes that "these IHSSs are not considered sources of contamination to groundwater because (1) soil or sediment

TABLE 5-1
CDPHE CONSERVATIVE SCREEN SUMMARY

IHSS or Location	Surface Soil	Subsurface Soil	Sediment		UHSU Ground-water	Surface Water ^{b/}
			Pond	Stream		
Sludge Dispersal Area (IHSS 141)	Yes ^{a/}	Yes	--	--	Yes	--
Pond A-1 (IHSS 142 1)	--	--	Yes	--	Yes	No
Pond A-2 (IHSS 142 2)	--	--	Yes	--	Yes	No
Pond A-3 (IHSS 142 3)	--	--	Yes	--	Yes	No
Pond A-4 (IHSS 142 4)	--	--	No	--	Yes	No
Pond B-1 (IHSS 142 5)	--	--	Yes	--	Yes	No
Pond B-2 (IHSS 142 6)	--	--	Yes	--	Yes	No
Pond B-3 (IHSS 142 7)	--	--	Yes	--	Yes	No
Pond B-4 (IHSS 142 8)	--	--	Yes	--	Yes	No
Pond B-5 (IHSS 142 9)	--	--	No	--	Yes	No
Walnut and Indiana Pond (IHSS 142 12)	--	--	No	--	Yes	No
Old Outfall (IHSS 143)	Yes	Yes	-	--	Yes	--
Soil Dump Area(IHSS 156 2)	Yes	Yes	--	--	--	--
Triangle Area (IHSS 165)	Yes	Yes	--	--	Yes	--
Trench A (IHSS 166 1)	No	No	--	--	Yes	--
Trench B (IHSS 166 2)	No	No	--	--	Yes	--
Trench C (IHSS 166 3)	No	No	--	--	Yes	--
North Area Spray Field (IHSS 167 1)	Yes	Yes	--	--	--	--
Former South Area Spray Field (F167 3)	No	No	--	--	Yes	--
East Area Spray Field ^{b/} (IHSS 216 1)	No	No	--	--	--	--
North Walnut Creek	--	--	--	Yes	--	--
South Walnut Creek	--	--	--	Yes	--	--
Upgradient	--	--	--	Yes	--	--
Walnut Creek at Indiana Street ^{b/}	--	--	--	No	--	--

NOTES

^{a/} "Yes" Indicates that COC concentrations for the IHSS or Location exceeds a risk ratio greater than one

^{b/} Shading indicates that IHSS, Location, or environmental media does not pose a significant risk to human health

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section CMS/FS Considerations
Page 5-4
Organization ER OU 5, 6, & 7 Closures

contaminant levels are so low that measurable impacts on groundwater are unlikely, (2) other sources of groundwater contamination are evident or suspected, or (3) maximum concentrations of COCs in the groundwater area under evaluation were observed at sampling locations remote from these IHSS. Therefore, these IHSSs are candidates for No Further Action based on negligible soil or sediment contamination and absence of IHSS-related groundwater contamination. Any groundwater associated with these IHSSs is expected to be addressed through other mechanisms. For example, groundwater at IHSSs 166 1 through 166 3 and F167 3 is expected to be remediated as warranted by systems used at for OU7. Groundwater associated with IHSSs 142 4 and 142 9 is expected to be remediated as warranted by systems potentially used to remediate groundwater areas 2, and 3, respectively. Groundwater at the Walnut and Indiana Pond will be better characterized during the RFI/RI report.

Based on the extremely small risk ratios presented for all surface water in Table 5-1, surface water as a medium is recommended for No Further Action in the CMS/FS. This conclusion is not specifically presented in the CDPHE Conservative Screen Report but is valid based on the low conservative health risks presented for OU6 surface water.

5.2 Remediation Target Screen

In addition to the CDPHE Conservative Screen, a second screen was performed to assist in scoping the CMS/FS. This screen was performed by comparing maximum COC concentrations for each environmental medium to the corresponding selected remediation target to determine which IHSSs could potentially be excluded from the CMS/FS. The results of the remediation target screen are summarized in Table 5-2. Shaded "No" entries indicate where the maximum COC concentration is below the selected remediation target. Shaded "--" entries indicate that the chemical is not identified as a COC for the environmental medium. The tables in Appendix G provide additional details of the remediation screen results including a comparison of the maximum COC concentration detected at each IHSS with the corresponding selected remediation target for each environmental medium. Units for the selected remediation targets on the Appendix G tables have been standardized to be consistent with the RFI/RI data.

The results of Table 5-2 shows that remediation of the surface and subsurface soils, and sediments is not required. The media which may require remediation include the UHSU groundwater and surface water (Ponds B-3 and B-4).

TABLE 5-2
REMEDIATION TARGET SCREEN SUMMARY

Human Health Chemical of Concern ^{a/}	Surface Soil	Subsurface Soil	Sediment		UHSU Ground- water	Surface Water
			Pond	Stream		
1,2-Dichloroethene	--	--	--	--	--	No
Acetone	--	--	--	--	--	No
Antimony	No	--	No	--	--	--
Aroclor-1254	--	--	No	--	--	--
Barium	--	No	--	--	--	--
Benzo(a)anthracene	--	--	--	No	--	--
Benzo(a)pyrene	--	No	No	No	--	--
Benzo(b)fluoranthene	--	No	No	No	--	--
Bis(2-ethylhexyl)phthalate	--	--	No	--	--	--
Chloroform	--	--	--	--	No	No
Cobalt	--	--	--	No	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	No	--	--
Methylene Chloride	--	No	--	--	Yes ^{b/}	Yes
Nitrate	--	--	--	--	Yes	--
Silver	No	--	No	--	--	--
Strontium	--	--	--	No	--	--
Tetrachloroethene	--	--	--	--	Yes	--
Trichloroethene	--	--	--	--	Yes	Yes
Vanadium	No	--	No	No	--	--
Vinyl Chloride	--	--	--	--	Yes	--
Zinc	No	--	No	No	--	--
Americium-241	No	No	No	No	No	--
Plutonium-239/240	No	No	No	No	No	--
Radium-226	--	--	--	--	No	--
Uranium-233/234	--	No	--	--	--	--
Uranium-238	--	No	--	--	--	--

NOTES

^{a/} Chemicals of Concern listed in Technical Memorandum No 4 (DOE, 1994a)

^{b/} "Yes" indicates that maximum COC concentration for the environmental medium exceeds the selected remediation target

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section CMS/FS Considerations
Page 5-6
Organization ER OU 5, 6, & 7 Closures

5.3 Conclusions

Based on results of the CDPHE conservative and remediation target screens, the following conclusions and recommendations are presented to form the initial basis for developing the OU6 CMS/FS

- **Surface and Subsurface Soils** - The results of the CDPHE conservative screen indicate that several IHSSs may require remediation for surface and subsurface soils. However, the results of the remediation target screen indicate surface and subsurface soil remediation is not required. This discrepancy stems from the selection of remediation targets for the radionuclide COCs which are based on the TBC level resulting in an effective dose equivalent of 100 mrem per year. Although this dose corresponds to a risk which exceeds 10^{-6} , the TBC level was chosen over other calculated risk-based PRGs as the remediation target since the NCP requires, in most cases, that ARARs or other available information be preferentially selected over risk-based PRGs as final remediation goals. As such, surface and subsurface soil remediation will not be considered in the CMS/FS, instead, a No Further Action determination will be sought for the OU6 surface and subsurface soils.
- **Pond and Stream Sediments** - The results of the CDPHE Conservative Screen indicate that most of the ponds and some portions of the streams at OU6 may require remediation for sediments. However, the results of the remediation target screen indicate that all COC concentrations are below their respective remediation target. Like soil, the discrepancy between the CDPHE and remediation target screens is likely due to the way the exposure to americium-241 detected in these sediments. It should be noted that the CDPHE screen indicates that the risk ratio for stream sediments is marginal (e.g., risk ratio is less than 10). Since the remediation target is based on a TBC levels, remediation of pond and stream sediments is not required. However, the elimination of pond sediments from remediation is contingent on current use of the ponds. In the event that the ponds are not maintained and become dry, the potential exposure to the sediments as surface soils may need to be considered in order to support a No Further Action decision.
- **Groundwater** - The results of the CDPHE Conservative Screen indicate that all groundwater areas at OU6 require remediation of groundwater. Based on the information provided in Appendix G, Groundwater Areas 1, 2, 3, and 5 have at least one COC which has a maximum concentration greater than the selected

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section CMS/FS Considerations
Page 5-7
Organization ER OU 5, 6, & 7 Closures

remediation target Any contamination that may be present in Groundwater Area 1 is suspected to be due to the OU7 landfill As such, this area is being considered to be administratively transferred to OU7 to further evaluate potential risk and the need to implement a remediation program The exceedence associated with Groundwater Area 2 is due to nitrate The source of this COC is believed to be the Solar Evaporation Ponds As such, it is proposed that this Groundwater Area be administratively transferred to OU4 to more effectively assess risks and potential remedial technologies The assessment of potential groundwater contamination and remediation needs for Groundwater Area 3 will be retained by OU6 The exceedence in the CDPHE Conservative screen risk ratio for Groundwater Area 4 is considered to be marginal As such Groundwater Area 4 is a candidate for a No Further Action determination The only exceedence for Groundwater Area 5 is due to methylene chloride which is a suspected laboratory contaminant As such, the need to remediate this Groundwater Area may not be appropriate With the administrative transfer of IHSS 143 to OU8, the responsibility for Groundwater Area 6 will also be transferred

- **Surface Water** - Based on the results of the CDPHE screen, surface water at OU6 does not have a risk ratio in excess of one As such, surface water could be a candidate for a No Further Action determination However, marginal exceedences of remediation targets are exhibited for methylene chloride (a suspected laboratory contaminant) and trichloroethene within Ponds B-3 (IHSS 142 7) and B-4 (IHSS 142 8) These exceedences may warrant further consideration with respect to the surface water classification since the remediation targets are based on drinking water Alternatively, the point of compliance to where these remediation targets need to be applied to ensure protection of the actual drinking water supplies should be factored into the remediation decision Since the maximum COC concentrations only marginally exceed the remediation targets, continued monitoring of the surface water may be preferred over developing remedial actions at this time
- **Other** - Although OU6 surface and subsurface soils do not need to be remediated based on the remediation target screen, it is proposed to administratively transfer the Old Outfall (IHSS 143) to OU8 (Industrial Area) due to the proximity of this IHSS with respect to the industrial area

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section CMS/FS Considerations
Page 5-8
Organization ER OU 5, 6, & 7 Closures

5.4 CMS/FS Recommendations

Based on the conclusions presented in Section 5.3, it is recommended that remedial technologies be developed for the following IHSSs/Locations, environmental media, and human health COCs

<u>IHSS/Location</u>	<u>Environmental Media</u>	<u>Human Health COCs</u>	<u>Comments</u>
Groundwater Area 1	Groundwater	Methylene Chloride Tetrachloroethene Trichloroethene	Transfer to OU7
Groundwater Area 2	Groundwater	Nitrate	Transfer to OU4
Groundwater Area 3	Groundwater	Methylene Chloride Trichloroethene Vinyl Chloride	Evaluate in OU6 CMS/FS
Groundwater Area 5	Groundwater	Methylene Chloride	Determine if result is due to laboratory contamination
Pond B-3 (IHSS 142 7)	Surface Water	Methylene Chloride	Determine if result is due to laboratory contamination Continue monitoring of surface water
Pond B-4 (IHSS 142 8)	Surface Water	Methylene Chloride Trichloroethene	Determine if results are due to laboratory contamination Continue monitoring of surface water

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	References
Revision B - Draft	Page	1
February, 1995	Organization	ER OU 5, 6, & 7 Closures

REFERENCES

- DOE, 1990 *Radiation Protection of the Public and Environment* DOE Order 5400 5
U S Department of Energy, Washington D C
- DOE, 1992 *Historical Release Report for the Rocky Flats Plant - Final* June, 1992
Manual No 21100-TR-12501 01
- DOE, 1993 *Final Background Geochemical Characterization Report* EG&G, Rocky Flats
Plant Golden, Colorado September
- DOE, 1994a *Technical Memorandum No 4, Chemicals of Concern Human Health Risk
Assessment Walnut Creek Priority Drainage Operable Unit No 6 - Draft
Final* Rocky Flats Environmental Technology Site, August
- DOE, 1994b *Letter Report Colorado Department of Public Health and Environment Source
Area Delineation and Risk Based Conservative Screen and Environmental
Protection Agency Areas of Concern Delineation, Human Health Risk
Assessment* Rocky Flats Environmental Technology Site, Final October
- DOE, 1994c *Draft Master List of Potential Federal and State ARARs for the Rocky Flats
Environmental Technology Site, Draft - November*, Letter from Steven Slaten
(DOE) to Mr Martin Hestmark (EPA) and Mr Joe Schieffelin (CDPHE)
dated November 8th (Reference 94-DOE-11232)
- DOE, 1995 *Programmatic Risk-Based Preliminary Remediation Goals - Final Revision 2*
U S Department of Energy, Rocky Flats Plant Golden, Colorado
February
- EG&G, 1991 *General Radiochemistry and Routine Analytical Services Protocol (GRRASP),
Part A, General Analytical Services Protocol (GASP), Organics, Inorganics,
Water Quality Parameters, Biochemistry, Biota - Statement of Work* Revision
2 EG&G Rocky Flats Environmental Management Department Rocky
Flats Plant Golden, Colorado
- EG&G, 1991a *General Radiochemistry and Routine Analytical Services Protocol (GRRASP),
Part B, Radioanalytical Services Protocol (RASP) - Statement of Work*
Revision 2 1 EG&G Rocky Flats Environmental Management Department
Rocky Flats Plant Golden, Colorado

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	References
Revision B - Draft	Page	2
February, 1995	Organization	ER OU 5, 6, & 7 Closures

- EG&G, 1992 *Phase I RFI/RI Workplan for Operable Unit No 6 - Walnut Creek Priority Drainage* May, 1992 Manual No 21100-WP-00 6 01
- EG&G, 1994 Letter from J H French to J Hopkins regarding Assessment of Potential Sand and Gravel Mining Land Use Scenario at Rocky Flats Operable Units August 18, 1994
- EPA, 1988 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* OSWER 9355 3-01 U S Environmental Protection Agency, Office of Emergency and Remedial Response Washington, D C
- EPA, 1990 *ARARs Q's & A's Compliance with Federal Water Quality Criteria* OSWER 9234 2-09/FS U S Environmental Protection Agency, Office of Solid Waste and Emergency Response Washington, D C
- EPA, 1991 *Human Health Evaluation Manual, Part B Development of Risk-Based Preliminary Remediation Goals* U S Environmental Protection Agency, Office of Emergency and Remedial Response Washington, D C
- EPA, 1992 *Supplemental Guidance to RAGS Calculating the Concentration Term* OSWER 9285 7-081 Environmental Protection Agency, Office of Solid Waste and Emergency Response Washington, D C
- IAG, 1991 *Rocky Flats Interagency Agreement Between the State of Colorado, the Environmental Protection Agency, and the Department of Energy*

APPENDIX A
OU6 IHSS DESCRIPTIONS

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Appendix A - IHSS Descriptions
Page A-1
Organization ER OU 5, 6, & 7 Closures

This appendix provides historical information regarding the operation of the IHSSs associated with OU6. The source of the information provided in this appendix was the Phase I RFI/RI *Workplan for Operable Unit No. 6 - Walnut Creek Priority Drainage* (EG&G, 1992) and the *Historical Release Report* dated June 1992 (DOE, 1992).

I. Sludge Dispersal Area (IHSS 141)

The Sludge Dispersal Area, IHSS 141, is located along the eastern perimeter of the security area of the RFETS. Two corrugated metal buildings located on the western half of the site house the drying beds for the RFETS Sewage Treatment Plant, which is located near the western perimeter of the site. Prior to 1983, the Sludge Dispersal Area may have received airborne radioactive particles from dried sludge packaging operations at the treatment plant. The area may also have been contaminated by spillage of dried or drying sludge from drying beds which were located just west of the site as shown in a 1964 aerial photograph. Between 1969 and 1972 laundry effluent was sent to the drying beds. By the end of 1972, only effluent sludges were sent to the drying beds since all other waste waters were channeled through the Sewage Treatment Plant. An overflow incident in June 1972 contributed to elevated levels of plutonium in the effluent which may have subsequently ended up in the drying beds.

Both metals and radioactive compounds were detected in the surface soil at this IHSS during the RFI/RI. Nearby groundwater well (Well 3686) was sampled and results indicated the presence of VOCs. Surface water location SW23 was also sampled, no significant detections of organics or pesticides/PCBs were reported, however, metals and radionuclides were detected.

II. Ponds (IHSSs 142.1 through 142.9, and 142.12)

Ten retention ponds were constructed along North and South Walnut Creeks. The ponds were generally constructed by the placement of an earthen embankment across the drainage channel. Outlets and spillways were constructed in some of the ponds to regulate downstream flow and channel excess water around the embankment when ponds are at capacity. The amount of water retained in the ponds varies seasonally, but is usually maintained at 10 percent of capacity. The ponds include the A-Series ponds, the B-Series ponds, and the Walnut and Indiana pond.

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Appendix A - IHSS Descriptions
Page A-2
Organization ER OU 5, 6, & 7 Closures

A. A-Series Ponds (IHSSs 142.1 through 142.5)

Ponds A-1 through A-4 (IHSSs 142.1 through 142.4, respectively) are located in North Walnut Creek, northeast of the main security area. The A-Series ponds are used to capture and control surface water runoff from the northern part of the RFETS production facilities and from North Walnut Creek. Historically, the ponds may have received discharges from a number of sources including untreated waste water, industrial wastes, and surface water. Between 1952 and 1979, Pond A-1 was used to hold laundry waste water that may have contained nitrates and radioactive substances, including plutonium and uranium. Pond A-1 also received process liquid waste, cooling tower blowdown and steam condensate discharges which may have contained chromates and algicides. The water from Pond A-1 was discharged into Pond A-2, after its construction in 1978, where the water was then disposed of by natural and spray evaporation. The discharges from the laundry and other production facilities to North Walnut Creek were discontinued. Currently, upstream flow is diverted around Pond A-1 and Pond A-2. Ponds A-1 and A-2 are used for spill control management and detention of local surface water runoff and seepage.

Pond A-3, constructed in 1971, was used to detain surface water runoff from the northern facilities and the creek prior to being discharged downstream. Pond A-4 was constructed in 1980 to receive water from Pond A-3 and water pumped from Pond B-5. The water in Pond A-4 is treated by a granulated activated carbon (GAC) system and discharged downstream into Walnut Creek.

Over the last several years, numerous investigations, concerned primarily with radioactivity levels, have been conducted on the water and sediment quality of the A-Series ponds. A 1979 study concluded that plutonium was in the pond sediments and in the water as suspended material. In 1980, a study was conducted to determine the vertical distribution of plutonium in the sediments. The study showed that the sediment had no significant vertical variation in plutonium concentration with depth, probably due to the shallow pond depth. The study also showed the concentration of plutonium in Pond A-1 was relatively low compared to the B-Series ponds. A study in 1986 confirmed the presence of plutonium in Pond A-1 and indicated that Pond A-2 had similar concentrations of plutonium and higher concentrations of uranium. Pond A-3 also showed elevated concentrations of uranium, and Pond A-4 water quality was similar to background concentrations. Results from the RFI/RI sampling indicate that pesticides, semivolatiles, metals, and radionuclides are present in the pond sediment.

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Appendix A - IHSS Descriptions
Page A-3
Organization ER OU 5, 6, & 7 Closures

B. B-Series Ponds (IHSSs 142.5 through 142.9)

Ponds B-1 through B-5 (IHSSs 142.5 through 142.9, respectively) are located in the South Walnut Creek drainage, east of the security area of RFETS. The B-Series ponds are used to manage surface water runoff from the eastern and central portions of the production facilities.

Between 1952 and 1973, decontaminated process and laundry waste waters were released to South Walnut Creek and flowed through Ponds B-1 to B-4. The wastes may have contained nitrate, plutonium, and uranium. In addition, Ponds B-1 and B-4 received sanitary effluent from the sewage treatment plant. Reconstruction activities between 1971 and 1973 caused upstream sediment to migrate to Pond B-1, which may have increased the plutonium inventory in that pond.

Presently, Ponds B-1 and B-2 are used for spill control management and to detain local surface water runoff and seepage. Pond B-3 receives effluent from the Sewage Treatment Plant at RFETS and local surface water runoff. The water is then discharged to Pond B-4 and subsequently to Pond B-5. Pond B-5 was constructed after 1979 and was used as an overflow pond for Pond B-4. In addition, Pond B-5 has periodically received water pumped from Pond C-2 since 1991.

Various investigations of the water and sediment quality within the B-Series ponds were conducted in conjunction with the investigations described above for the A-Series ponds. The investigations indicated that plutonium was present in most of the ponds, with the highest concentrations in Pond B-1. The plutonium concentrations in the B-Series ponds were also typically higher than those detected in the A-Series ponds. Results of the RFI/RI indicate that, metals, pesticides, semivolatiles, and radionuclides are present in the pond sediment.

C. Walnut and Indiana Pond (IHSS 142.12)

One additional pond, IHSS 142.12, is located approximately 2,500 feet east of the confluence of the North and South Walnut Creeks and immediately west (upstream) of Indiana Street. This pond is used to measure the flow of Walnut Creek using two Parcel flumes. In addition, the pond is used to settle out sediments transported in North and South Walnut Creeks. The effluent is sampled on a daily basis when discharge from the pond into Walnut Creek is occurring. Results of the RFI/RI sampling indicate the presence of semivolatiles in the sediment.

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Appendix A - IHSS Descriptions
Page A-4
Organization ER OU 5, 6, & 7 Closures

III. Old Outfall (IHSS 143)

The Old Outfall (IHSS 143) is located northwest of the Guard Station within the security area. The outfall acted as a catchment basin receiving liquids from various sources, mainly the laundry waste water holding tanks from Building 771. The laundry waste water was discharged to the outfall if levels of plutonium were low (i.e., below 3,300 disintegrations per minute per liter). In 1956 and 1958, soils contaminated with plutonium were discovered, however, it is not known if the contaminated areas were remediated. In 1957, a waste line was installed to convey the laundry waste water to Building 774. However, during 1957 and 1965, periodic equipment problems caused the discharge of waste water to the Old Outfall area and subsequently into North Walnut Creek. In addition to the laundry waste water, the Old Outfall received discharges from the analytical laboratory, radiography sinks, the personnel decontamination room, and surface water runoff from the buildings and surrounding area. In 1968, a broken sewer line caused the sewage lift station tank to overflow onto the Old Outfall area. In 1970, hot spots of radioactive materials were detected in the soils and as a result contaminated soil was removed from an area of approximately 75 square feet located between the outfall and the stream. In 1971, another remedial action was performed to remove approximately 800 square feet of soil contaminated with plutonium. Metals were detected in the surface soil at this IHSS during the RFI/RI sampling. Metals, semivolatiles, volatiles, and low levels of plutonium and uranium were detected in the subsurface soil.

IV. Soil Dump Area (IHSS 156.2)

The Soil Dump Area (IHSS 156.2) is located within the buffer zone, immediately adjacent to the northeastern boundary of the RFETS security area. The IHSS is located on an interfluvium separating the North and South Walnut Creeks. The area covers approximately 225,000 square feet. This area received between 50 to 70 dump truck loads of soil excavated during the construction of Parking Area No. 334. The excavated soils from the parking area had been originally excavated from around and near Building 774 and may have contained low levels of plutonium. Asphalt debris and concrete are also found within the Soil Dump Area. Results of the RFI/RI indicate the presence of metals, volatiles, and radionuclides at low levels in both the surface and subsurface soil at the site.

V. Triangle Area (IHSS 165)

The Triangle Area (IHSS 165) is located within the RFETS security area between the Northeast Perimeter Road on the north and Spruce Avenue on the south. The area covers approximately 250,000 square feet. The western two-thirds of this site is located within the Security Area. The area is partially vegetated and has been covered with an unknown amount of

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Appendix A - IHSS Descriptions
Page A-5
Organization ER OU 5, 6, & 7 Closures

gravel fill This area was used as a storage site for miscellaneous wastes between 1966 and 1975. The site was first used to store the drums removed from a field north of Building 883 due to construction of a new decontamination facility. Various scrap materials were stored in the drums including graphite molds, crucibles, incinerator ash heels, crucible heels, raschig rings, and combustible wastes. The drums were stored until they could be processed for plutonium in Building 771. By the end of 1968, about 5,000 drums had been stored in the Triangle Area. High winds damaged a number of the drums in December 1968. In May 1969, wastes from a fire in Building 776 were drummed and stored in the Triangle area. These wastes may have contained plutonium. On five separate occasions, in 1969, 1971, and three times in 1973, leaking drums were discovered at the site. In each instance, contaminated soil was removed. By 1975, all containers were removed from the area and shipped to approved disposal facilities. The area has not been used for storage of radioactive materials since then, however some equipment and piping is currently stored in the area. By early 1980, additional soil indicating a radioactivity above background was removed. During the RFI/RI, radionuclides were detected in the surface soil and semivolatiles, metals, and radionuclides were detected in subsurface soils.

VI. Trenches (IHSSs 166.1 through 166.3)

Trenches A, B, and C (IHSSs 166.1 through 166.3, respectively) are located north of the RFETS security area on a plateau separating North Walnut Creek and the unnamed tributary to the north. Little documentation is available concerning the operational history of the trenches, but they most likely received sludge from the RFETS Sewage Treatment Plant. The primary chemicals in the sludges are believed to be radionuclides. Investigations of the sites indicate that low levels of radionuclides, metals, and semivolatiles are present in the subsurface soil.

A. Trench A (IHSS 166.1)

Trench A (IHSS 166.1) is located about 100 feet southeast of the present landfill. This trench is estimated to have been active from 1964 until 1974. This trench may have received uranium and/or plutonium contaminated sludge from the RFETS Sewage Treatment Plant. No other wastes were known to have been placed in the trench. RFI/RI sampling indicated that barium, methylene chloride, and plutonium were present in the subsurface soil at low levels.

B. Trench B (IHSS 166.2)

Trench B (IHSS 166.2) is located approximately 125 feet south of Trench A. Operation of this trench began around 1959. The closure date of this trench is unknown, however it is estimated to have operated through 1988. Similar to Trench A, this site is believed to have

Technical Memorandum No 1	Document Number	RF/ER-95-0015
Corrective/Remedial Action Objectives	Section	Appendix A - IHSS Descriptions
Revision B - Draft	Page	A-6
February, 1995	Organization	ER OU 5, 6, & 7 Closures

received only sludge from the RFETS Sewage Treatment Plant RFI/RI sampling indicated that barium, methylene chloride, and americium were present in the subsurface soil at low levels

C. Trench C (IHSS 166.3)

Trench C (IHSS 166 3) consists of two separate trenches The first trench is located between Trench A and Trench B, and the second trench is located approximately 300 feet east of Trench A Trench C was active between 1964 and 1974 It is assumed that these trenches also received sewage sludge, but the operational history is uncertain Sampling during the RFI/RI indicated that barium, methylene chloride and radionuclides were present in the subsurface soil

VII. North Area Spray Field (IHSS 167.1)

The North Area Spray Field (IHSS 167 1) is partially located on the plateau area that bounds the unnamed tributary on North Walnut Creek The North Area Spray Field is located near the Original Landfill OU7 The North Are Spray Field was used to spray and evaporate the water that collected in the East and West Landfill Ponds and the water in Pond B-3 The exact periods during which this IHSS was operational is not precisely known, however, it is believed that spray irrigation occurred shortly after the present landfill became active in 1968 The ponds were used to impound leachate from the landfill and to intercept groundwater that may have been contaminated by leachate During operation of this spray field, surface water drainage was draining into the unnamed tributary of North Walnut Creek, and subsequently into Walnut Creek Operation of this spray field was discontinued and spray evaporation was moved to the Pond Area Spray Field The field is presently not used and is covered by grasses common to the Rocky Flats Area Sampling during the RFI/RI indicated the presence of radionuclides in the surface soil and barium, methylene chloride, and radionuclides in the subsurface soil

VIII. Former South Area Spray Field (F167.3)

The original location of the South Area Spray Field (F167 3) is located near the North Area Spray Field on the plateau between an unnamed tributary and North Walnut Creek During the course of the OU6 characterization activities, it was determined that the South Area Spray Field was actually located further north, adjacent to the landfill pond The original IHSS 167 3 location has been designated as the Former South Area Spray Field (F167 3) in order to distinguish it from the current IHSS 167 3 being addressed as part of OU7 Although F167 3 is being retained for completeness, this location is not formally considered an IHSS The original location of the South Area Spray Field is presently covered by grasses common to the area The results of the RFI/RI indicated that methylene chloride and toluene (potential laboratory

Technical Memorandum No 1
Corrective/Remedial Action Objectives
Revision B - Draft
February, 1995

Document Number RF/ER-95-0015
Section Appendix A - IHSS Descriptions
Page A-7
Organization ER OU 5, 6, & 7 Closures

contaminants) and radionuclides and metals were detected in surface soils. In subsurface soils, 2-butanone (a potential laboratory contaminant) and strontium were detected.

IX. East Area Spray Field (IHSS 216.1)

The East Area Spray Field (IHSS 216.1) is located within the buffer zone, northeast of the security area. This spray field became operational in 1989 to provide an additional area for evaporation of the water from Pond B-3, which consisted of surface water runoff and effluent from the RFETS Sewage Treatment Plant. The use of this spray field was stopped shortly after it became operational due to excessive runoff draining toward South Walnut Creek. Radionuclides were detected in the surface soil and metals, volatiles, and radionuclides were detected in the subsurface soil during the RFI/RI sampling.

APPENDIX B

**REASONABLE MAXIMUM EXPOSURE AND
CENTRAL TENDENCY EXPOSURE FACTORS**

TABLE B-1
EXPOSURE FACTORS FOR SOIL/DUST INGESTION

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Ingestion Rate Child (mg/day)	RME ^(1,3) CT ^(2,4)	200 100	NA NA	NA NA	NA NA	NA NA
Ingestion Rate Adult (mg/day)	RME ⁽³⁾ CT ⁽⁴⁾	100 50	50 ⁽³⁾ 5 ⁽⁵⁾	480 ⁽³⁾ 95 ⁽⁶⁾	50 ⁽³⁾ 15 ^(5,7)	50 ⁽¹³⁾ 10 ⁽¹³⁾
Exposure Frequency (days/yr)	RME ⁽³⁾ CT ⁽⁸⁾	350 245	250 ⁽³⁾ 219 ⁽⁴⁾	30 ⁽³⁾ 30 ⁽³⁾	65 ⁽³⁾ 65 ⁽³⁾	250 ⁽¹⁴⁾ 219 ⁽¹⁴⁾
Exposure Duration Child/Adult (years)	RME ⁽³⁾ CT ⁽⁹⁾	6 / 24 2 / 7	25 ⁽³⁾ 4 ⁽¹⁰⁾	1 ⁽³⁾ 1 ⁽³⁾	2 5 ⁽³⁾ 2 5 ⁽³⁾	25 ⁽¹⁵⁾ 4 ⁽¹⁵⁾
Body Weight Child/Adult (kg)	RME ⁽³⁾ CT ⁽³⁾	15 / 70 15 / 70	70 ⁽³⁾ 70 ⁽³⁾	70 ⁽³⁾ 70 ⁽³⁾	70 ⁽³⁾ 70 ⁽³⁾	70 ⁽¹⁶⁾ 70 ⁽¹⁶⁾
Averaging Time - Child/Adult (days) ⁽¹¹⁾	RME ⁽³⁾ CT ⁽³⁾	2190 / 8760 730 / 2555	9125 1460	365 365	915 915	9125 1460
Averaging Time Carcinogen (days) ⁽¹²⁾	RME ⁽³⁾ CT ⁽³⁾	25550 25550	25550 25550	25550 25550	25550 25550	25550 25550

NOTES

(NA) Not applicable, only an adult exposure was assessed for exposure pathway

(1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment. RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to characterize the high-end risks to a very small proportion of an exposed population.

(2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values).

Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population.

(3) Final Rocky Flats Programmatic Risk-Based Preliminary Remediation Goals, DOE, 1994

- (9) Preliminary CT default values, adding to 9 years total exposure duration (EPA, 1993)
- (10) American Industrial Health Council, 1994, Gephart, Tell, and Triemer, 1994
- (11) Exposure duration (years) x 365 days (EPA RAGS, HHM Part A, 1989)
- (12) Lifetime exposure (70 years) x 365 days (EPA RAGS HHM Part A, 1989)
- (13) RME RAGS, HHM, Standard Default Exposure Factors, (EPA, 1991) CT Inferred from Finley and Paustenbach, 1994, average of CT soil ingestion rates of 15 mg/day (outdoor industrial worker) and 5 mg/day (indoor industrial worker)
- (14) RME RAGS, HHM, Standard Default Exposure Factors (EPA, 1991) CT Preliminary default value (EPA, 1993)
- (15) RME RAGS, HHM, Standard Default Exposure Factors (EPA, 1991) CT American Industrial Health Council (1994)
- (16) RAGS, HHM, Standard Default Exposure Factors (EPA, 1991)

(4) Preliminary CT default value (EPA, 1993)

(5) Average of CT soil ingestion rates of 15 mg/day (outdoor industrial worker) and 5 mg/day (indoor industrial worker) based on inferences drawn from Finley and Paustenbach, 1994 Soil ingestion rates for workers indoors (e.g., office workers) are one-half the average of workers both indoors and outdoors (e.g., industrial workers)

(6) Estimated using HE ingestion rate ratio of construction worker to industrial worker ($480/50 = 9.6$, $CT = 9.6 \times 10 \text{ mg/day}$), but a more defensible CT default is 40

(7) Three times the office worker based on inferences drawn from Finley and Paustenbach, 1994, soil ingestion rates for workers outdoors (e.g., ecological workers) are three times the rates for workers indoors (e.g., office workers)

(8) Average of two exposure frequencies outdoor soil/dust CT value of 150 days (Finley and Paustenbach, 1994) and indoor dust CT value of 335 days, assuming 15 days of vacation travel and 15 days of employment travel or overnight visits

TABLE B-2
EXPOSURE FACTORS FOR SOIL/DUST INHALATION

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Inhalation Rate (m ³ /hr)	RME <input type="checkbox"/>	0 83 ^(1,3)	0 83 ⁽³⁾	1 25 ⁽³⁾	0 83 ⁽³⁾	0 83 ⁽¹³⁾
	CT <input type="checkbox"/>	0 63 ^(2,4)	0 63 ^(3,5)	1 25 ⁽³⁾	0 83 ⁽³⁾	0 83 ⁽¹³⁾
Exposure Time (hr/day)	RME <input type="checkbox"/>	24 ⁽³⁾	8 ⁽³⁾	8 ⁽³⁾	8 ⁽³⁾	12 ⁽¹⁴⁾
	CT <input type="checkbox"/>	15 ⁽⁶⁾	7 2 ⁽⁷⁾	7 2 ⁽⁷⁾	7 2 ⁽⁸⁾	10 ⁽¹⁴⁾
Exposure Frequency (days/yr)	RME <input type="checkbox"/>	350 ⁽³⁾	250 ⁽³⁾	30 ⁽³⁾	65 ⁽³⁾	250 ⁽¹⁵⁾
	CT <input type="checkbox"/>	245 ⁽⁸⁾	219 ⁽⁸⁾	30 ⁽³⁾	65 ⁽³⁾	219 ⁽¹⁵⁾
Exposure Duration (years)	RME <input type="checkbox"/>	30 ⁽³⁾	25 ⁽³⁾	1 ⁽³⁾	2 5 ⁽³⁾	25 ⁽¹⁶⁾
	CT <input type="checkbox"/>	9 ⁽⁹⁾	4 ⁽¹⁰⁾	1 ⁽³⁾	2 5 ⁽³⁾	4 ⁽¹⁶⁾
Body Weight (kg)	RME <input type="checkbox"/>	70 ⁽³⁾	70 ⁽³⁾	70 ⁽³⁾	70 ⁽³⁾	70 ⁽¹³⁾
	CT <input type="checkbox"/>	70 ⁽³⁾	70 ⁽³⁾	70 ⁽³⁾	70 ⁽³⁾	70 ⁽¹³⁾
Averaging Time	RME <input type="checkbox"/>	10950	9125	365	915	9125
Non-carcinogen (days) ⁽¹²⁾	CT <input type="checkbox"/>	3285	1460	365	915	1460
Averaging Time	RME <input type="checkbox"/>	25550	25550	25550	25550	25550
Carcinogen (days) ⁽¹³⁾	CT <input type="checkbox"/>	25550	25550	25550	25550	25550

NOTES

- (1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment. RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to characterize the high-end risks to a very small proportion of an exposed population.
- (2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk

assessment (or a "reasonable worst case" when used in combination with selected high-end values). Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population.

(3) Final Rocky Flats Programmatic Risk-Based Preliminary Remediation Goals, DOE 1994

(4) CT residential inhalation rate (adult) based on EPA RAGS, HHEM Part B, 1991a

- (5) CT worker inhalation rate of 0.63 m³/hr (adult indoors) based on EPA Exposure Factors Handbook, 1989a
- (6) Based on average time spent at home (0.64 adult) (American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994)
- (7) Based on average time spent at work (36 hr/wk) (American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994)
- (8) Preliminary CT default value (EPA, 1993)
- (9) Preliminary CT default value (EPA, 1993)
- (10) American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994
- (11) Exposure duration (years) x 365 days (EPA RAGS, HHEM Part A, 1989)
- (12) Lifetime exposure (70 years) x 365 days (EPA RAGS, HHEM Part A, 1989)
- (13) RAGS, HHEM, Standard Default Exposure Factors (EPA, 1991)
- (14) Mining Exposure Scenario for Baseline Risk Assessments at the Rocky Flats Environmental Technology Site (DOE, 1994a)
- (15) RME RAGS, HHEM, Standard Default Exposure Factors (EPA, 1991) CT Preliminary default value (EPA, 1993)
- (16) RME RAGS, HHEM, Standard Default Exposure Factors (EPA, 1991) CT American Industrial Health Council (1994)

TABLE B-3
EXPOSURE FACTORS FOR GROUND WATER INGESTION

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Ingestion Rate (L/day)	RME ⁽¹⁾	20 ^(1,3)	NA	NA	NA	NA
	CT ^(2,4)	14 ^(2,4)	NA	NA	NA	NA
Exposure Frequency (days/yr)	RME ⁽³⁾	350 ⁽³⁾	NA	NA	NA	NA
	CT ⁽⁵⁾	335 ⁽⁵⁾	NA	NA	NA	NA
Exposure Duration (years)	RME ⁽³⁾	30 ⁽³⁾	NA	NA	NA	NA
	CT ⁽⁶⁾	9 ⁽⁶⁾	NA	NA	NA	NA
Body Weight (kg)	RME ⁽³⁾	70 ⁽³⁾	NA	NA	NA	NA
	CT ⁽³⁾	70 ⁽³⁾	NA	NA	NA	NA
Averaging Time	RME ⁽⁷⁾	10950	NA	NA	NA	NA
Non-carcinogen (days)	CT ⁽⁷⁾	3285	NA	NA	NA	NA
Averaging Time	RME ⁽⁸⁾	25550	NA	NA	NA	NA
Carcinogen (days)	CT ⁽⁸⁾	25550	NA	NA	NA	NA

NOTES

(NA) Not applicable, only residential exposure pathway considered in analysis

(1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment. RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to characterize the high-end risks to a very small proportion of an exposed population

(2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values). Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population

(3) Final Rocky Flats Programmatic Risk-Based Preliminary Remediation Goals, DOE, 1994

(4) HE and CT adult total water-based beverage intakes, including tap water (EPA Exposure Factors Handbook, 1989a)

- (5) Assuming 15 days of vacation travel and 15 days of employment travel (7) Exposure duration (years) x 365 days (EPA RAGS, HHM Part A, 1989)
- (6) Preliminary CT default value (EPA, 1993) (8) Lifetime exposure (70 years) x 365 days (EPA RAGS, HHM Part A, 1989)

TABLE B-4
EXPOSURE FACTORS FOR GROUND WATER AND SUBSOIL VOC INHALATION *

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Inhalation Rate (m ³ /hr)	RME ^(1,3) CT ^(2,6)	0 63 0 63	0 83 ⁽³⁾ 0 63 ⁽⁴⁾	1 25 ⁽³⁾ 1 25 ⁽³⁾	NA NA	NA NA
Exposure Time (hr/day)	RME ⁽³⁾ CT ⁽⁷⁾	24 15	8 ⁽³⁾ 7 2 ⁽⁶⁾	8 ⁽³⁾ 7 2 ⁽⁶⁾	NA NA	NA NA
Exposure Frequency (days/yr)	RME ⁽³⁾ CT ⁽⁸⁾	350 234	250 ⁽³⁾ 219 ⁽⁸⁾	30 ⁽³⁾ 30 ⁽³⁾	NA NA	NA NA
Exposure Duration (years)	RME ⁽³⁾ CT ⁽⁸⁾	30 9	25 ⁽³⁾ 4 ⁽⁹⁾	1 ⁽³⁾ 1 ⁽³⁾	NA NA	NA NA
Body Weight (kg)	RME ⁽³⁾ CT ⁽³⁾	70 70	70 ⁽³⁾ 70 ⁽³⁾	70 ⁽³⁾ 70 ⁽³⁾	NA NA	NA NA
Averaging Time	RME ⁽³⁾ CT ⁽³⁾	10950 3285	9125 1460	365 365	NA NA	NA NA
Non-carcinogen (days) ⁽¹⁰⁾	RME ⁽³⁾ CT ⁽³⁾	25550 25550	25550 25550	25550 25550	NA NA	NA NA
Averaging Time	RME ⁽³⁾ CT ⁽³⁾	25550 25550	25550 25550	25550 25550	NA NA	NA NA
Carcinogen (days) ⁽¹¹⁾	RME ⁽³⁾ CT ⁽³⁾	25550 25550	25550 25550	25550 25550	NA NA	NA NA

* Includes *indoor* VOC vapor from household use of a groundwater supply and VOC vapor infiltration from subsoil into homes and offices, also *outdoor* VOC vapor from subsoil excavation at construction sites

NOTES

(NA) Not applicable because the exposure pathway is incomplete

(1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment. RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to

characterize the high-end risks to a very small proportion of an exposed population

(2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values). Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to

characterize the mid-range risk to the largest proportion of an exposed population

- (3) Final Rocky Flats Programmatic Risk-Based Preliminary Remediation Goals, DOE, 1994
- (4) CT worker inhalation rate of 0.63 m³/hr (adult indoors) based on EPA Exposure Factors Handbook, 1989a
- (5) CT residential inhalation rate (adult indoors) based on EPA RAGS, HHM, Standard Default Exposure Factors, 1991
- (6) Based on average time spent at work (36 hr/wk) (American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994)

- (7) Based on average time spent at home (0.64 adult, 0.82 child) (American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994)
- (8) Preliminary CT default value (EPA, 1993)
- (9) American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994
- (10) Exposure duration (years) x 365 days (EPA RAGS, HHM Part A, 1989)
- (11) Lifetime exposure (70 years) x 365 days (EPA RAGS, HHM Part A, 1989)

TABLE B-5
EXPOSURE FACTORS FOR EXTERNAL RADIATION

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Gamma Exposure Time Factor (Te)	RME <input checked="" type="checkbox"/>	1 0 ⁽¹⁾	0 3 ⁽³⁾	0 3 ⁽³⁾	0 3 ⁽³⁾	0 3 ⁽¹¹⁾
	CT <input checked="" type="checkbox"/>	0 75 ^(2 5)	0 3 ⁽⁴⁾	0 3 ⁽⁴⁾	0 3 ⁽⁴⁾	0 3 ⁽¹¹⁾
Gamma Shielding Factor (1-Se)	RME <input checked="" type="checkbox"/>	0 8 ⁽⁶⁾	0 8 ⁽⁶⁾	0 8 ⁽⁶⁾	0 8 ⁽⁶⁾	0 8 ⁽¹²⁾
	CT <input checked="" type="checkbox"/>	0 5 ⁽⁷⁾	0 5 ⁽⁷⁾	0 8 ⁽⁸⁾	0 8 ⁽⁸⁾	0 8 ⁽¹²⁾
Exposure Frequency (days/yr)	RME <input checked="" type="checkbox"/>	350 ⁽³⁾	250 ⁽³⁾	30 ⁽³⁾	65 ⁽³⁾	250 ⁽¹³⁾
	CT <input checked="" type="checkbox"/>	234 ⁽⁹⁾	219 ⁽⁹⁾	30 ⁽³⁾	65 ⁽³⁾	219 ⁽¹³⁾
Exposure Duration (years)	RME <input checked="" type="checkbox"/>	30 ⁽³⁾	25 ⁽³⁾	1 ⁽³⁾	2 5 ⁽³⁾	25 ⁽¹⁴⁾
	CT <input checked="" type="checkbox"/>	9 ⁽⁹⁾	4 ⁽¹⁰⁾	1 ⁽³⁾	2 5 ⁽³⁾	4 ⁽¹⁴⁾

NOTES

- | | |
|--|---|
| <p>(1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment. RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to characterize the high-end risks to a very small proportion of an exposed population</p> | <p>(3) Final Rock Flats Programmatic Risk-Based Remediation Goals, DOE, 1994</p> |
| <p>(2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values). Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population</p> | <p>(4) Assuming the HE fraction of time exposed (8 out of 24 hours or 0 33) according to EPA RAGS, HHEM Part B - Revised (Dinan, 1992)</p> <p>(5) Assuming the CT fraction of time spent at home (average of adult - 0 64 and child - 0 82) (American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994)</p> <p>(6) Standard default screening value specified in EPA RAGS, HHEM Part B, 1991b (1 - 0 2 = 0 8), assuming substantial time shielded by structures</p> <p>(7) Estimated typical value for residents and indoor workers shielded by buildings (DOE documents for RFP, such as "Mining Exposure Scenario for Baseline Risk Assessments at the Rocky Flats Environmental Technology Site" (DOE, 1994a))</p> |

- | | | | |
|------|---|------|--|
| (8) | Assumed typical value for outdoor workers with only limited shielding indoors | (12) | RAGS, HHEM Part B (EPA, 1991a), assuming limited time shielded by structures |
| (9) | Preliminary CT default value (EPA, 1993) | (13) | RME RAGS, HHEM, Standard Default Exposure Factors (EPA, 1991) CT Preliminary default value (EPA, 1993) |
| (10) | American Industrial Health Council, 1994, Gephart, Tell and Triemer, 1994 | (14) | RME RAGS, HHEM, Standard Default Exposure Factors (EPA, 1991) CT American Industrial Health Council (1994) |
| (11) | EPA RAGS, HHEM Part B - Revised (Dinan, 1992) | | |

TABLE B-6
EXPOSURE FACTORS FOR SURFACE WATER INGESTION

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Ingestion Rate (L/hr)	RME ⁽⁵⁾	0 05	NA	NA	0 05 ⁽¹³⁾	NA
	CT ⁽⁴⁾	0 01	NA	NA	0 01 ^(2,4)	NA
Exposure Time (hr/day)	RME ⁽⁷⁾	2 6	NA	NA	1 ⁽⁶⁾	NA
	CT ⁽⁸⁾	1	NA	NA	1 ⁽⁶⁾	NA
Exposure Frequency (days/yr)	RME ⁽⁹⁾	7	NA	NA	7 ⁽³⁾	NA
	CT ⁽¹⁰⁾	5	NA	NA	7 ⁽³⁾	NA
Exposure Duration (years)	RME ⁽¹¹⁾	30	NA	NA	2 5 ⁽³⁾	NA
	CT ⁽¹²⁾	9	NA	NA	2 5 ⁽³⁾	NA
Body Weight (kg)	RME ⁽¹¹⁾	70	NA	NA	70 ⁽³⁾	NA
	CT ⁽¹¹⁾	70	NA	NA	70 ⁽³⁾	NA
Averaging Time Non-carcinogen (days) ⁽¹³⁾	RME ⁽¹³⁾	10950	NA	NA	915	NA
	CT ⁽¹³⁾	3285	NA	NA	915	NA
Averaging Time Carcinogen (days) ⁽¹⁴⁾	RME ⁽¹⁴⁾	25550	NA	NA	25550	NA
	CT ⁽¹⁴⁾	25550	NA	NA	25550	NA

NOTES

(NA) Not applicable because exposure route is not complete

(1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to characterize the high-end risks to a very small proportion of an exposed population

(2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk assessment (or a "reasonable worst case" when used in combination with selected high-end values) Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population

(3) Final Rock Flats Programmatic Risk-Based Preliminary Remediation Goals, 1994

- (4) On the premise that actual swimming rather than wading is unlikely, the CT ingestion rate while wading is assumed to be one-fifth as much as while swimming
- (5) Default value for ingestion of surface water and suspended sediment while swimming (EPA RGAS, HHEM, Part A, 1989), wading ingestion rate is indeterminate from available sources
- (6) An exposure "event" for the ecological worker (see Final Rocky Flats Programmatic Risk-Based Preliminary Remediation Goals, 1994) is assumed to last 1 hour per day
- (7) Default value for swimming exposure time (EPA RGAS, HHEM, Part A, 1989), wading ingestion rate is indeterminate from available sources
- (8) On the premise that actual swimming rather than wading is unlikely, the CT exposure time is assumed to be 1 hour
- (9) Default value for swimming exposure frequency (EPA RGAS, HHEM, Part A, 1989), wading ingestion rate is indeterminate from available sources
- (10) On the premise that actual swimming rather than wading is unlikely, the CT exposure frequency while wading is assumed to be 5 events per year
- (11) Appendix B 1, EPA RAGS, HHEM Part B, 1991a
- (12) Preliminary CT default value (EPA, 1993) A current alternative value is EPA's CT Residential Occupancy Period (ROP) of 8 1 years for total population (EPA, 1992b, American Industrial Health Council, 1994)
- (13) Exposure duration (years) x 365 days (EPA RAGS, HHEM Part A, 1989b)
- (14) Lifetime exposure (70 years) x 365 days (EPA RAGS, HHEM Part A, 1989b)

TABLE B-7
EXPOSURE FACTORS FOR SEDIMENT INGESTION

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Ingestion Rate (mg/day)	RME <input type="checkbox"/>	50 ^(1,3)	NA	NA	NA	NA
	CT <input type="checkbox"/>	50 ⁽²⁾	NA	NA	NA	NA
Exposure Frequency (days/yr)	RME <input type="checkbox"/>	7 ⁽³⁾	NA	NA	NA	NA
	CT <input type="checkbox"/>	7 ⁽³⁾	NA	NA	NA	NA
Exposure Duration (years)	RME <input type="checkbox"/>	30 ⁽³⁾	NA	NA	NA	NA
	CT <input type="checkbox"/>	9	NA	NA	NA	NA
Body Weight (kg)	RME <input type="checkbox"/>	70 ⁽³⁾	NA	NA	NA	NA
	CT <input type="checkbox"/>	70 ⁽³⁾	NA	NA	NA	NA
Averaging Time	RME <input type="checkbox"/>	10950	NA	NA	NA	NA
Non-carcinogen (days) ⁽⁴⁾	CT <input type="checkbox"/>	3285	NA	NA	NA	NA
Averaging Time	RME <input type="checkbox"/>	25550	NA	NA	NA	NA
Carcinogen (days) ⁽⁵⁾	CT <input type="checkbox"/>	25550	NA	NA	NA	NA

NOTES

(NA) Not applicable because exposure route is not complete

(1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment. RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to characterize the high-end risks to a very small proportion of an exposed population

(2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk

assessment (or a "reasonable worst case" when used in combination with selected high-end values). Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population

(3) Final Rock Flats Programmatic Risk-Based Preliminary Remediation Goals, 1994

(4) Exposure duration (years) x 365 days (EPA RAGS, HHM Part A, 1989b)

(5) Lifetime exposure (70 years) x 365 days (EPA RAGS, HHM Part A, 1989b)

TABLE B-8
EXPOSURE FACTORS FOR SEDIMENT INHALATION

FACTORS FOR POTENTIALLY COMPLETE ROUTES OF EXPOSURE		Resident	Office Worker	Construction Worker	Ecological Worker	Gravel Mine Worker
Inhalation Rate (m ³ /day)	RME <input checked="" type="checkbox"/>	2 ^(1,3)	NA	NA	NA	NA
	CT <input checked="" type="checkbox"/>	2 ⁽²⁾	NA	NA	NA	NA
Exposure Frequency (days/yr)	RME <input checked="" type="checkbox"/>	7 ⁽³⁾	NA	NA	NA	NA
	CT <input checked="" type="checkbox"/>	7 ⁽³⁾	NA	NA	NA	NA
Exposure Duration (years)	RME <input checked="" type="checkbox"/>	30 ⁽³⁾	NA	NA	NA	NA
	CT <input checked="" type="checkbox"/>	9	NA	NA	NA	NA
Body Weight (kg)	RME <input checked="" type="checkbox"/>	70 ⁽³⁾	NA	NA	NA	NA
	CT <input checked="" type="checkbox"/>	70 ⁽³⁾	NA	NA	NA	NA
Averaging Time	RME <input checked="" type="checkbox"/>	10950	NA	NA	NA	NA
Non-carcinogen (days) ⁽⁴⁾	CT <input checked="" type="checkbox"/>	3285	NA	NA	NA	NA
Averaging Time	RME <input checked="" type="checkbox"/>	25550	NA	NA	NA	NA
Carcinogen (days) ⁽⁵⁾	CT <input checked="" type="checkbox"/>	25550	NA	NA	NA	NA

NOTES:

(NA) Not applicable because exposure route is not complete

(1) Top entry is based on High-End (HE) exposure used to characterize the Reasonable Maximum Exposure (RME) risks in a baseline or remediation risk assessment RME risks are derived using professional judgment to set one or more sensitive exposure parameters at HE (90-98th percentile) values in combination with others set at Central Tendency (CT) values in order to characterize the high-end risks to a very small proportion of an exposed population

(2) Bottom entry is based on Central Tendency (CT) used to characterize the typical case in a baseline or remediation risk

assessment (or a "reasonable worst case" when used in combination with selected high-end values) Average risks are derived using professional judgment to set all exposure parameters at 50th percentile (median) or mean values in order to characterize the mid-range risk to the largest proportion of an exposed population

(3) Final Rock Flats Programmatic Risk-Based Preliminary Remediation Goals, 1994

(4) Exposure duration (years) x 365 days (EPA RAGS, HHM Part A, 1989b)

(5) Lifetime exposure (70 years) x 365 days (EPA RAGS, HHM Part A, 1989b)

REFERENCES TO LITERATURE AND DOCUMENTS

- American Industrial Health Council (AIHC) 1994 *Exposure Factors Sourcebook* AIHC, Washington, DC
- Calabrese, E J and E J Stanek III 1992 Distinguishing outdoor soil ingestion from dust ingestion in a Soil Pica Child *Regulatory Toxicology and Pharmacology* 15 83-85
- Calabrese, E J and E J Stanek III 1991 A guide to interpreting soil ingestion studies II Qualitative and quantitative evidence of soil ingestion *Regulatory toxicology and Pharmacology* 13 278-292
- Calabrese, E J and E J Stanek III C E Gilbert, and R M Barnes 1991 Preliminary adult soil ingestion estimates Results of a pilot study *Regulatory Toxicology and Pharmacology* 12 88-95
- Calabrese, E J , R M Barnes E J Stanek III, H Pastides, C E Gilbert, P Veneman, X Wang, A Lastity and P T Kosteckı 1989 How much soil to young children ingest? - An epidemiological study *Regulatory Toxicology and Pharmacology* 10 123-137
- Dinan, J 1992 "Changes to Equations in the Part B Guidance " Memorandum dated 9 November to EPA Regional Toxic Integration Coordinators
- DOE 1994 "Final Programmatic Risk-Based Preliminary Remediation Goals " Rocky Flats Plant, Golden CO (July) (unpublished)
- DOE 1992 *Rocky Flats Plant Site Environmental Report for 1992* Prepared by EG&G Rocky Flats
- EPA 1994 *Guidance Manual for the Integrated Exposure and Uptake Biokinetic Model for Lead in Children* Office of Emergency and Remedial Response EPA-540-R-93-081
- EPA 1993 "Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure " (unpublished preliminary review draft, dated 4 November)
- EPA 1992a *Dermal Exposure Assessment Principles and Applications* Office of Health and Environmental Assessment EPA/600/8-91/011b
- EPA 1992b A Monte Carlo Approach to Simulating Residential Occupancy Periods and Its Application to the General Population Office of Air Quality EPA-450/3-92-011
- EPA 1992c "New Region IV Interim Guidance " Regional Office Memorandum dated 11 February
- EPA 1992d "Dermal Absorption Factors for Multiple Chemicals " Headquarters Memorandum dated 15 December
- EPA 1992e Exposure Assessment Guidelines *Federal Register* 57(104) 22888-22934

- EPA 1992f "Supplemental Guidance to RAGS Calculation the Concentration Term " OSWER Publication 9285 7-081
- EPA 1991a "Supplemental Guidance to RAGS Standard Default Exposure Factors (Interim Final) " OSWER Directive 9285 6-03
- EPA 1991b *Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health Evaluation Manual, Part B- Development of Risk-Based Preliminary Remediation Goals* OSWER Directive 9285 7-01B
- EPA 1991c "Guidance for Risk Assessment " Risk Assessment Council, Washington, DC (unpublished)
- EPA 1989a *Exposure Factors Handbook* Office of Health and Environmental Assessment EPA/600/8-89/043
- EPA 1989b *Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health and Evaluation Manual , Part A - Interim Final* EPA/540/1-89/002
- Finley, B , and D Paustenbach 1994 The benefits of probabilistic exposure assessment Three case studies involving contaminated air, water, and soil *Risk Analysis* 14(1) 53-73
- Gephart, L A , J G Tell and L R Triemer 1994 Exposure factors manual *Journal of Soil Contamination* 3(1) 47-117
- Hawley, J K 1985 Assessment of health risks from exposure to contaminated soil *Risk Analysis* 5 289-302
- National Academy of Sciences 1994 *Science and Judgment in the Federal Government Managing the Process* Washington DC National Academy Press
- Paustenbach, D , H Shu, and F Murray 1986 A critical examination of assumptions used in risk assessment of dioxin-contaminated soil *Regulatory and Toxicology and Pharmacology* 6 284-313
- Sedman, R M 1988 The development of applied action levels for soil contact A scenario for the exposure of humans to soil in a residential setting *Environmental Health Perspectives* 79 291-313
- Stanek II, E S 1991 A guide to interpreting soil ingestion studies- Development of a model to estimate the soil ingestion detection level of soil ingestion studies *Regulatory Toxicology and Pharmacology* 13 263-277

APPENDIX C

CHEMICAL-SPECIFIC TOXICITY
INFORMATION FOR OU6 CHEMICALS OF CONCERN

TABLE C-1
COC--Specific Toxicity Values *

Target Analyte List Chemical	Oral RfD (mg/kg-day)	Oral Slope Factor (mg/kg-day) ⁻¹	Inhalation RfD (mg/kg-day)	Inhalation Slope Factor (mg/kg-day) ⁻¹	External Slope Factor (risk/yr per pCi/g)	Henry's Law Constant (atm-m ³ /mol)	Koc (ml/g)	Water Solubility (mg/L)	Diffusivity
Acetone#	1.00E-01	-	-	-	-	2.06E-05 e	2.2 e	1.00E+06 e	0.1093 f
Antimony	4.00E-04	-	-	-	-	-	-	-	-
Aroclor-1254	-	7.70E+00	-	-	-	1.07E-03 e	53000 e	-	0.0557
Barium	7.00E-02	-	1.43E-04 b	-	-	-	-	-	-
Benzo(a)anthracene	-	7.30E-01 c	-	-	-	1.16E-06 e	138000 e	-	-
Benzo(a)pyrene	-	7.30E+00	-	-	-	1.55E-06 e	550000 e	-	-
Benzo(b)fluoranthene	-	7.30E-01 c	-	-	-	1.19E-05 e	55000 e	-	-
bis(2-Ethylhexyl)phthalate	2.00E-02	1.40E-02	-	-	-	1.00E-04	1000	-	-
Chloroform#	1.00E-02	6.10E-03	-	8.05E-02	-	2.87E-03 e	31 e	8.20E+03 e	0.0940 f
Cobalt	6.00E-02	-	-	-	-	-	-	-	-
1,2-Dichloroethene (total)#	9.00E-03 b	-	-	-	-	-	36	-	0.0838 f
Indeno(1,2,3-cd)pyrene	-	7.30E-01 c	-	-	-	6.86E-08 e	160000 e	-	-
Methylene chloride#	6.00E-02	7.50E-03	8.57E-01	1.64E-03	-	-	48	-	-
Silver	5.00E-03	-	-	-	-	-	-	-	-
Strontium	6.00E-01	-	-	-	-	-	-	-	-
Tetrachloroethene#	1.00E-02	5.20E-02 d	-	2.03E-03	-	2.59E-02 e	364 e	-	0.0785 f
Trichloroethene#	-	1.10E-02	-	5.95E-03	-	9.10E-03 e	126 e	1.10E+03 e	0.0860 f
Vanadium	7.00E-03 b	-	-	-	-	-	-	-	-
Zinc	3.00E-01	-	-	-	-	-	-	-	-
Nitrate	1.60E+00	-	-	-	-	-	-	-	-
Americium-241	-	2.40E-10 b*	-	3.20E-08 b*	4.90E-09 b	-	-	-	-
Plutonium-239	-	2.30E-10 b*	-	3.80E-08 b*	1.70E-11 b	-	-	-	-
Plutonium-240	-	2.30E-10 b*	-	3.80E-08 b*	2.70E-11 b	-	-	-	-
Radium-226+D	-	1.20E-10 b*	-	3.00E-09 b*	6.00E-06 b	-	-	-	-
Uranium-233+D	-	1.60E-11 b*	-	2.70E-08 b*	4.20E-11 b	-	-	-	-
Uranium-234	-	1.60E-11 b*	-	2.60E-08 b*	3.00E-11 b	-	-	-	-
Uranium-235+D	-	1.60E-11 b*	-	2.50E-08 b*	2.40E-07 b	-	-	-	-
Uranium-238+D	-	2.00E-11 b*	-	2.40E-08 b*	5.10E-08 b	-	-	-	-

= Chemicals listed are volatile

* = Values given are in units of risk/pCi

a = All toxicity values are from IRIS, February 1994 unless otherwise noted

b = Value from HEAST, 1993

c = Values given for PAHs were found in the EPA guidance document "Research and Development--

Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons"

d = Values given for tetrachloroethene are from a U.S. EPA memo from the Office of Research and

Development Environmental Criteria and Assessment Office

e = Values given are found in the Superfund Public Health Evaluation Manual, 1986

f = Values given are found in the Superfund Exposure Assessment Manual, 1988

APPENDIX D

**RISK-BASED PRELIMINARY REMEDIATION GOAL
EQUATIONS FOR OU6 SEDIMENTS**

TABLE D-1
SEDIMENTS - RESIDENTIAL RECREATIONAL USE
CARCINOGENIC EFFECTS

$$PRG_1 = \frac{TR \times BW \times AT}{ED \times EF \times \left[(IR_o \times SF_o \times 10^6 \text{ kg/mg}) + (IR_i \times SF_i \times \frac{1}{PEF}) \right]}$$

where

Variable	Explanation (Units)
PRG ₁	OU-specific PRG (carcinogen effects) for sediments based on residential recreational use (mg/kg)
TR	Target excess lifetime cancer risk (unitless)
AT	Averaging time (days)
BW	Body weight (kg)
ED	Exposure duration (years)
EF	Exposure frequency (days/year)
IR _o	Sediment ingestion rate (mg/day)
SF _o	Oral cancer slope factor (mg/kg-day) ⁻¹
IR _i	Sediment inhalation rate (m ³ /day)
SF _i	Inhalation cancer slope factor (mg/kg-day) ⁻¹
PEF	Particulate emission factor (m ³ /kg)

Note Inhalation of particulates does not apply to VOCs (i.e., Henry's Law Constant greater than 1 x 10⁻⁵ atm-m³/mole and a molecular weight less than 200 g/mole)

TABLE D-2
SEDIMENTS - RESIDENTIAL RECREATIONAL USE
NONCARCINOGENIC EFFECTS

$$PRG_2 = \frac{THI \times BW \times AT}{ED \times EF \times \left[(IR_o \times 10^6 \text{ kg/mg} \times \frac{1}{RfD_o}) + (IR_i \times \frac{1}{PEF} \times \frac{1}{RfD_i}) \right]}$$

where

<u>Variable</u>	<u>Explanation (Units)</u>
PRG ₂	OU-specific PRG (noncarcinogen effects) for sediments based on residential recreational use (mg/kg)
THI	Target hazard index (unitless)
BW	Body weight (kg)
AT	Averaging time (days)
ED	Exposure duration (years)
EF	Exposure frequency (days/year)
IR _o	Sediment ingestion rate (mg/day)
RfD _o	Oral chronic reference dose (mg/kg-day)
IR _i	Sediment inhalation rate (m ³ /day)
PEF	Particulate emission factor (m ³ /kg)
RfD _i	Inhalation chronic reference dose (mg/kg-day)

Note Inhalation of particulates does not apply to VOCs (i.e., Henry's Law Constant greater than 1 x 10⁻⁵ atm-m³/mole and a molecular weight less than 200 g/mole)

TABLE D-3
SEDIMENTS - RESIDENTIAL RECREATIONAL USE
RADIOLOGICAL EFFECTS

$$PRG_3 = \frac{ED \times \left[(EF \times IR_o \times SF_o \times 10^{-3} \text{ g/mg}) + (EF \times IR_i \times SF_i \times 10^3 \text{ g/kg} \times \frac{1}{PEF}) + (SF_e \times (1 - S_e) \times T_e) \right]}{TR}$$

where

<u>Variable</u>	<u>Explanation (Units)</u>
PRG ₃	OU-specific PRG (radiological effects) for sediment based on residential recreational use (pCi/g)
TR	Target excess lifetime cancer risk (unitless)
ED	Exposure duration (years)
EF	Exposure frequency (days/year)
IR _o	Sediment ingestion rate (mg/day)
SF _o	Oral cancer slope factor (risk/pCi)
IR _i	Sediment inhalation rate (m ³ /day)
SF _i	Inhalation cancer slope factor (risk/pCi)
PEF	Particulate emission factor (m ³ /kg)
SF _e	external exposure slope factor (risk/yr per pCi/g)
S _e	gamma shielding factor (unitless)
T _e	gamma exposure factor (unitless)

APPENDIX E
POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARs/TBCs ^{a1/}

CHEMICAL OF CONCERN	SOIL CLEANUP CRITERIA		SAFE DRINKING WATER ACT				RESOURCE CONSERVATION AND RECOVERY ACT		DOE Order 5400.5 ^{e1/}
	FEDERAL	STATE	FEDERAL ^{e1/}		STATE ^{e2/}	FEDERAL	STATE		
			MCL (ug/L)	MCLG (ug/L)					
TSCA - PCBs			6	6	6			Derived Concentration Guides for Drinking Water ^{e2/}	
			2,000	2,000	2,000	1,000	1,000		
			10,000	10,000	10,000				
			100 ^{e4/}			50	50		
			5,000 ^{e4/}						
			70	70	70				
			100	100	100				
			1 to 25 ppm ^{b2, m1/}	0.5 ^{b2/}	0 ^{b2/}	0.5 ^{b2/}			
Benzo(a)anthracene									
Benzo(a)pyrene			0.2	0	0.2				
Benzo(b)fluoranthene									

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARs/TBCs ^{a1/}

CHEMICAL OF CONCERN	SOIL CLEANUP CRITERIA		SAFE DRINKING WATER ACT				RESOURCE CONSERVATION AND RECOVERY ACT		DOE Order 5400.5 ^{a1/}
	FEDERAL	STATE	FEDERAL ^{a1/}		STATE ^{a2/}		FEDERAL	STATE	
	TSCA - PCBs		MCL (ug/L)	MCLG (ug/L)	MCL (ug/L)		Groundwater Protection Standards ^{a1/} (ug/L)	Groundwater Protection Standards ^{a2/} (ug/L)	Derived Concentration Guides for Drinking Water ^{a2/}
bis (2-Ethylhexyl) phthalate			6	0 ^{a3/}	6				
Chloroform			<100 ^{a3/}		<100 ^{a3/}				
Indeno (1,2,3-cd) pyrene									
Methylene Chloride			5	0 ^{a3/}	5				
Tetrachloroethene			5	0 ^{a3/}	5				
Trichloroethene			5	0 ^{a3/}	5				
Vinyl Chloride			2	0 ^{a3/}	2				
Americium-241			< 15 pCi/L ^{b1, a1/}		< 15 pCi/L ^{b1, a1/}				30 pCi/L
Plutonium-239/240			< 15 pCi/L ^{b1, a1/}		< 15 pCi/L ^{b1, a1/}				30 pCi/L
Radium-226			< 15 pCi/L ^{b1, a1/}		< 15 pCi/L ^{b1, a1/}				100 pCi/L
Radium-226 + 228			5 pCi/L ^{a1/}		5 pCi/L ^{a1/}				100 pCi/L
Uranium-233/234 (pCi/l)			— ^{b1, a1/}		— ^{b1, a1/}				500 pCi/L
Uranium-238 (pCi/l)			— ^{b1, a1/}		— ^{b1, a1/}				600 pCi/L

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARS/TBCs^{a1/}

STATE - GROUNDWATER QUALITY STANDARDS									
CHEMICAL OF CONCERN	STATEWIDE STANDARDS ^{a1/}				SITE-SPECIFIC STANDARDS FOR ROCKY FLATS AREA ^{a1/}				
	Radioactive Materials Standards ^{a2/}	Table A Interim Organic Standards ^{a2, a3/} (ug/L)	Table 1 and 2 Human Health Domestic Use ^{a3/} (ug/L)	Table 3 Agriculture (ug/L)	Table 1 and 2 Human Health Domestic Use ^{a3/} (ug/L)	Table 3 Agriculture (ug/L)	Table 5 Additional Organic Chemical Standards (ug/L)	Table 6 Radionuclides Woman Creek ^{a2, a3/}	Table 6 Radionuclides Walnut Creek ^{a2, a3/}
Antimony			6 ^{b4/}		6 ^{b4/}				
Barium			1,000 ^{b4/}		1,000 ^{b4/}				
Cobalt				50 ^{b4/}		50 ^{b4/}			
Nitrate as N			10,000 ^{b4/}	100,000 ^{b4, b3/}	10,000 ^{b4/}	100,000 ^{b4, b3/}			
Silver			50 ^{b4/}		50 ^{b4/}				
Strontium									
Vanadium				100 ^{b4/}		100 ^{b4/}			
Zinc			5,000 ^{b4, b3/}	2,000 ^{b4/}	5,000 ^{b4, b3/}	2,000 ^{b4/}			
1,2-Dichloroethene (cis)		70							
1,2-Dichloroethene (total)									
1,2-Dichloroethene (trans)		100							
Acetone									
Aroclor-1254		1 (0 005) ^{b2, b3/}					1 (0 000079) ^{b2, b3/}		
Benzo(a)anthracene							1 (0 0028) ^{b3, b2/}		
Benzo(a)pyrene		0 2					1 (0 0028) ^{b3, b2/}		
Benzo(b)fluoranthene							1 (0 0028) ^{b3, b2/}		

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARs/TBCs ^{a1/}

STATE - GROUNDWATER QUALITY STANDARDS									
CHEMICAL OF CONCERN	STATEWIDE STANDARDS ^{a1/}				SITE-SPECIFIC STANDARDS FOR ROCKY FLATS AREA ^{a1/}				
	Radioactive Materials Standards ^{a1/}	Table A Interim Organic Standards ^{a1, a3/} (ug/L)	Table 1 and 2 Human Health Domestic Use ^{a1/} (ug/L)	Table 3 Agriculture (ug/L)	Table 1 and 2 Human Health Domestic Use ^{a1/} (ug/L)	Table 3 Agriculture (ug/L)	Table 5 Additional Organic Chemical Standards (ug/L) ^{a1/}	Table 6 Radionuclides Woman Creek ^{a1, a3/}	Table 6 Radionuclides Walnut Creek ^{a1, a3/}
bis (2-Ethylhexyl) phthalate		6							
Chloroform		6					1 (0.19) ^{b3/}		
Indeno (1,2,3-cd) pyrene							1 (0.0028) ^{b3, b12/}		
Methylene Chloride		5							
Tetrachloroethene		5					1 (0.8) ^{b3/}		
Trichloroethene		5							
Vinyl Chloride		2							
Americium-241			< 15 pCi/L ^{b1 b4/}		< 15 pCi/L ^{b1 b4/}			0.05 pCi/L ^{a1/}	0.05 pCi/L ^{a1/}
Plutonium-239/240	15 pCi/L		< 15 pCi/L ^{b1 b4/}		< 15 pCi/L ^{b1 b4/}			0.05 pCi/L ^{a1/}	0.05 pCi/L ^{a1/}
Radium-226			< 15 pCi/L ^{b1 b4/}		< 15 pCi/L ^{b1 b4/}			< 7 pCi/L ^{a10/}	< 11 pCi/L ^{a10/}
Radium-226+228	5 pCi/L		< 15 pCi/L ^{b1 b4/}		< 15 pCi/L ^{b1 b4/}				
Uranium-233/234 (pCi/l)			-- ^{b1/}		-- ^{b1/}			5 pCi/L ^{a1/}	10 pCi/L ^{a1/}
Uranium-238 (pCi/l)			-- ^{b1/}		-- ^{b1/}			5 pCi/L ^{a1/}	10 pCi/L ^{a1/}

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARs/TBCs ^{a1/}

CHEMICAL OF CONCERN	CLEAN WATER ACT - FEDERAL STANDARDS SECTION 304a AMBIENT WATER QUALITY CRITERIA ^{a1/}				CLEAN WATER ACT - EPA REGION VIII SECTION 304a AMBIENT WATER QUALITY CRITERIA ^{b1/}			
	AWQC FOR PROTECTION OF HUMAN HEALTH ^{a2/}		AWQC FOR PROTECTION OF AQUATIC LIFE - FRESH WATER		UPDATED AWQC FOR PROTECTION OF HUMAN HEALTH		PUBLISHED AWQC FOR PROTECTION OF AQUATIC LIFE - FRESH WATER	
	Water and Fish Ingestion (ug/L)	Fish Consumption Only (ug/L)	Acute Value (ug/L)	Chronic Value (ug/L)	Water and Fish Ingestion (ug/L)	Fish Consumption Only (ug/L)	Acute Value (ug/L)	Chronic Value (ug/L)
Antimony	146 (14)	45,000 (4,300)	88 ^{a3/}	30 ^{a3/}	14	4300		
Barium	1000				1,000			
Cobalt								
Nitrate as N	10,000				10,000			
Silver	50 (91)		4 1 ^{a4/} (0 92) ^{a3/}	0 12 ^{a3/}	170 ^{a7/}	110,000 ^{a7/}	4 1 ^{a4/}	
Strontium								
Vanadium								
Zinc			120 ^{a4/}	110 ^{a4/}	9,100	69,000	120 ^{a4/}	110 ^{a4/}
1,2-Dichloroethene (cis)								
1,2-Dichloroethene (total)								
1,2-Dichloroethene (trans)	(700)	(140,000)			700	140,000		
Acetone								
Aroclor-1254	0 000079 ^{b2/} (0 000044)	0 000079 ^{b2/} (0 000045)	2 0 ^{b2/}	0 014 ^{b2/}	0 000044	0 000045		
Benzo(a)anthracene	(0 0028)	(0 0311)			0 0044	0 049		
Benzo(a)pyrene	(0 0028)	(0 0311)			0 0044	0 049		
Benzo(b)fluoranthene	(0 0028)	(0 0311)			0 0044	0 049		

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARs/TBCs ^{a1/}

CHEMICAL OF CONCERN	CLEAN WATER ACT - FEDERAL STANDARDS SECTION 304a AMBIENT WATER QUALITY CRITERIA ^{a1/}				CLEAN WATER ACT - EPA REGION VIII SECTION 304a AMBIENT WATER QUALITY CRITERIA ^{a1/}			
	AWQC FOR PROTECTION OF HUMAN HEALTH ^{a2/}		AWQC FOR PROTECTION OF AQUATIC LIFE - FRESH WATER		UPDATED AWQC FOR PROTECTION OF HUMAN HEALTH		PUBLISHED AWQC FOR PROTECTION OF AQUATIC LIFE - FRESH WATER	
	Water and Fish Ingestion (ug/L)	Fish Consumption Only (ug/L)	Acute Value (ug/L)	Chronic Value (ug/L)	Water and Fish Ingestion (ug/L)	Fish Consumption Only (ug/L)	Acute Value (ug/L)	Chronic Value (ug/L)
bis (2-Ethylhexyl) phthalate	15,000 (1 8)	50,000 (5 9)	400 ^{a3/}	360 ^{a3/}	1 8	5 9		
Chloroform	0 19 (5 7)	15 7 (470)	28,900 ^{a3/}	1,240 ^{a3/}	5 7	470		
Indeno (1,2,3-cd) pyrene	(0 0028)	(0 0311)			0 0044	0 049		
Methylene Chloride	(4 7)	(1,600)			4 7	1,600		
Tetrachloroethene	0 8	8 85	5,820 ^{a3/}	840 ^{a3/}	0 8	8 9		
Trichloroethene	2 7 (2 7)	80 7 (81)	45,000 ^{a3/}	21,900 ^{a3/}	2 7	81		
Vinyl Chloride	2	525			2	530		
Americium-241								
Plutonium-239/240								
Radium-226								
Radium-226 + 228								
Uranium-233/234 (pCi/l)								
Uranium-238 (pCi/l)								

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARs/TBCs ^{a1/}

CHEMICAL OF CONCERN	SURFACE WATER QUALITY STANDARDS									
	STATEWIDE STANDARDS ^{11/}					REETS SITE-SPECIFIC STANDARDS ^{11/}		NPDES PERMIT LIMITS ^{k1/}		
	Radioactive Materials Standards ^{w/}	Human Health Water Supply ^{13, 14/} (ug/L)	Human Health Water and Fish ^{13, 15/} (ug/L)	Aquatic Life Acute Value ^{16/} (ug/L)	Aquatic Life Chronic Value ^{16/} (ug/L)	Segment 4 ^{12/} (ug/L)	Segment 5 ^{12/} (ug/L)	Outfall 001 Pond B-3 ^{k2/} (ug/L)	Outfall 002 Pond A-3 ^{k3/} (ug/L)	Outfalls 005 & 006, Ponds A-4 & B-5 ^{k4/} (ug/L)
Antimony										
Barium										
Cobalt										
Nitrate as N						10,000	10 000	10,000 ^{k5/} 20,000 ^{k6/}	10,000 ^{k5/} 20,000 ^{k7/}	
Silver						TVS ^{14/}	TVS ^{14/}			
Strontium										
Vanadium										
Zinc						TVS ^{14/}	350 ^{k6, 18/}			
1,2-Dichloroethene (cis)	70									
1,2-Dichloroethene (total)										
1,2-Dichloroethene (trans)	100		100							
Acetone										
Aroclor-1254	0 005 ^{k2/}	0 000044 ^{k2/}	2 ^{k2/}	0 014 ^{k2/}		1 (0 000044) ^{k2, k3/}	1 (0 000044) ^{k2, k3/}			
Benzo(a)anthracene			0 0044			10 (0 0028) ^{k3/}	10 (0 0028) ^{k3/}			
Benzo(a)pyrene	0 0044	0 0044	0 0044			10 (0 0028) ^{k3/}	10 (0 0028) ^{k3/}			
Benzo(b)fluoranthene			0 0044			10 (0 0028) ^{k3/}	10 (0 0028) ^{k3/}			

Table E-1
POTENTIAL CHEMICAL SPECIFIC ARARs/TBCs ^{a1/}

SURFACE WATER QUALITY STANDARDS										
CHEMICAL OF CONCERN	STATEWIDE STANDARDS ^{11/}					REETS SITE-SPECIFIC STANDARDS ^{11/}		NPDES PERMIT LIMITS ^{k1/}		
	Radioactive Materials Standards ^{12/}	Human Health Water Supply ^{13, 14/} (ug/L)	Human Health Water and Fish ^{13, 15/} (ug/L)	Aquatic Life Acute Value ^{16/} (ug/L)	Aquatic Life Chronic Value ^{16/} (ug/L)	Segment 4 ^{12/} (ug/L)	Segment 5 ^{12/} (ug/L)	Outfall 001 Pond B-3 ^{12/} (ug/L)	Outfall 002 Pond A-3 ^{13/} (ug/L)	Outfalls 005 & 006, Ponds A-4 & B-5 ^{14/} (ug/L)
bis (2-Ethylhexyl) phthalate			1 8							
Chloroform		< 100 ^{13/}	< 100 ^{13/}	28,900	1,240	6	6			
Indeno (1,2,3-cd) pyrene			0 0044			10 (0 0028) ^{13/}	10 (0 0028) ^{13/}			
Methylene Chloride		5	5			4 7	4 7			
Tetrachloroethene		5	0 8	5,280	840	1 (0 8) ^{13/}	76 ^{18/}			
Trichloroethene		5	2 7	45,000	21,900		66 ^{18/}			
Vinyl Chloride		2	2							
Americium-241						0 05 pCi/L ^{11/}	0 05 pCi/L ^{11/}			
Plutonium-239/240	15 pCi/L					0 05 pCi/L ^{11/}	0 05 pCi/L ^{11/}			
Radium-226	5 pCi/L					<7 pCi/L ^{110, 16/}	<7 pCi/L ^{110, 16, 19/}			
Radium-226 + 228	5 pCi/L					<11 pCi/L ^{110, 17/}	<11 pCi/L ^{110, 17, 19/}			
Uranium-233/234 (pCi/l)						5 pCi/L ^{11, 16, 19/}	5 pCi/L ^{11, 16, 19/}			
Uranium-238 (pCi/l)						10 pCi/L ^{11, 17/}	10 pCi/L ^{11, 17, 19/}			

EXPLANATION OF TABLE AND ENDNOTES

- a1/ Values which are shaded are not considered ARARs but have been included in this table for completeness. Explanations regarding why these values are not considered to be ARARs are provided in the footnotes. Shaded values will be considered as TBCs where pertinent.
- b1/ Value is based on total gross alpha particle activity (Includes Ra-226, but excludes radon and uranium)
- b2/ Value is based on total PCBs
- b3/ Where the water quality standard is below (more stringent than) the PQL, the PQL is interpreted to be the compliance level [See 5 CCR 1002-8, Section 3.1.14(9) for surface water quality standards and 5 CCR 1002-8, Section 3.11.5(C)(4) for ground water quality standards]. The value provided in Table E-1 is the PQL detection limit. The value in parentheses is the water quality standard.
- b4/ Value is measured as a dissolved concentration
- b5/ Value is based on an average dose equivalent of 4 mrem per year for all beta particles and photon activity. Value provided equates to a 4 mrem per year dose for the individual radionuclide. Where multiple radionuclides are present, the sum of the individual ratios between radionuclide concentrations and the calculated 4 mrem per year limits is not to exceed one.
- b6/ Standard is measured as a total recoverable concentration
- c1/ Values are based on EPA National Primary Drinking Water Regulations, 40 CFR 141 (Last Revision 59 FR 34322, July 1, 1994). MCLGs which are set at zero are not obtainable, as such, zero standards are not considered to be ARARs or TBCs.
- c2/ Values are based on 5 CCR 1003-1 (Last update 17 CR 9, 9-94, effective 9/30/94)
- c3/ Value is based on total trihalomethanes which includes trichloromethane (chloroform), tribromomethane (bromoform), bromodichloromethane, and dibromochloromethane.
- c4/ Value is based on EPA National Secondary Drinking Water Regulations, 40 CFR 143 (Last Revision 56 FR 3597, January 30, 1991). Since value is a secondary standard, it is considered to be a TBC.

EXPLANATION OF TABLE AND ENDNOTES

- d1/ Values are based on 40 CFR 264.94 (Last Revision 59 FR 48042, September 19, 1994)
- d2/ Values are based on 6 CCR 1007-3, 264.94 (Last Revision 17 CR 8, Effective August 30, 1994)
- e1/ Values are based on DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (Last revision Change 2, January 7, 1993)
- e2/ Derived Concentration Guides (DCGs) provided are based on a residential exposure route for the ingestion of water (See DOE Order 5400.5, Chapter 3 for exposure factors and assumptions used to calculate the DCGs) The DCGs are based on a committed effective dose equivalent of 100 mrem for the individual radionuclide taken into the body by ingestion during a one year period Where multiple radionuclides are present, the sum of the individual ratios between radionuclide concentrations and the corresponding DCGs is not to exceed one

EXPLANATION OF TABLE AND ENDNOTES

- f1/ Statewide values are based on 5 CCR 1002-8, Section 3 11 5 (Last update 17 CR 3, Effective 3/30/94) Table 4, TDS Standards, not provided since TDS is not listed as a COC Despite questions regarding enforceability, the Statewide groundwater standards for groundwater that has not been classified for a specific or potential use will be considered potential ARARs, except standards for AEA regulated radionuclides As such, Statewide standards associated with an use classification and AEA regulated radionuclides are not considered to be ARARs These values will be considered as TBCs where pertinent

[NOTES Section 3 11 5(C)(5) states that 1) for the purpose of implementing CERCLA, the selection of a remedial action and a point of compliance, that are more or less stringent than would be achieved by compliance with a Statewide or site-specific standard is not precluded, 2) for the purpose of implementing RCRA hazardous waste management regulations and/or corrective actions, selecting background levels, establishing alternative concentration limits, or specifying an alternate point of compliance, that are more or less stringent than would be achieved by compliance with a Statewide or site-specific standard is not precluded, and 3) for the purpose of implementing the storage tank program, issuing a regulatory determination, including a point of compliance, that are more or less stringent than would be achieved by compliance with a Statewide or site-specific standard is not precluded The requirements for establishing a point of compliance are identified in 5 CCR 1002-8, Section 3 11 6 Per 5 CCR 1002-8, Section 3 11 5, the Statewide standards apply to all State groundwaters unless alternative site-specific standards have been adopted Although site-specific groundwater standards have been adopted for the Rocky Flats area under 5 CCR 1002-8, Section 3 12 7(1), the site-specific groundwater use classifications, and their associated standards, and the RFETS site-specific standards are not considered ARARs because those use classifications, and their associated standards, and the RFETS site-specific standards have not been generally applied to other remedial sites throughout the State RFETS is the only industrial site in Colorado that has groundwater use classifications of domestic use quality, agricultural use quality, and surface water protection imposed upon it RFETS is the only industrial site in Colorado to have site-specific standards for parameters that have probably been used at other industrial sites in Colorado As such, the Statewide groundwater standards not associated with an use classification will be considered potential ARARs for remediating groundwater at OU6

- f2/ Standards established for AEA regulated radionuclides are not considered to be ARARs because the AEA grants DOE authority over AEA regulated radionuclides
- f3/ Value is provided as nitrite plus nitrate ($\text{NO}_2 + \text{NO}_3 - \text{N}$)

EXPLANATION OF TABLE AND ENDNOTES

- f4/ Site-specific values are based on 5 CCR 1002-7, Section 3 12 7 (Last update 17 CR 8, effective 8/30/94) Since the standards and associated use classifications have not been applied or developed consistently throughout the State, they are not ARARs (Also see footnote f2/) These shaded Statewide values are listed in table for completeness and will be considered as TBCs where pertinent
- f5/ If these radionuclides values were considered to be ARARs, values would apply only to ground water hydraulically connected to Woman Creek
- f6/ If these radionuclides values were considered to be ARARs, values would apply only to ground water hydraulically connected to Walnut Creek
- f7/ Individual values are based on total activity concentration for Am, Pu, or U, respectively
- f8/ All values are from Table 1, Human Health Standards, unless otherwise noted
- f9/ Value is from Table 2, Secondary Drinking Water
- f10/ Value is based on total gross alpha activity
- f11/ Value is based on total gross beta activity
- f12/ Value is based on total PAHs
- f13/ These interim values remain in effect until alternative permanent standards are adopted by the Colorado Water Quality Control Commission or site-specific standards are established The interim values are not subject to restrictions such as antibacksliding or downgrading
- g1/ EPA Water Quality Criteria values based on May 1, 1991 Water Quality Criteria Summary table Note This table is an update to the 1989 Water Quality Criteria "Gold Book"
- g2/ Values are based on published AWQC for protection of human health Values in parentheses are water quality criterion which have been recalculated using September, 1990 IRIS data These recalculated values are considered TBCs
- g3/ Water quality criterion provided is proposed

EXPLANATION OF TABLE AND ENDNOTES

- g4/ Water quality criterion is dependent on hardness Value provided is based on hardness concentration of 100 mg/L CaCO₃
- g5/ Insufficient data is available to develop water quality criterion Value presented is the lowest observed effect level
- g6/ Value is for chromium III
- g7/ Value is based on published recommendation and criteria document, however, EPA did not promulgate the human health criteria in the National Toxics Rule Where a value is provided, it is based on information from IRIS
- h1/ EPA Region VIII AWQC is based on July 14, 1993 letter from Dale Vodehnal, Chief, Water Quality Branch which was to provide States and Tribes latest scientific information in support of State and Tribal water quality standard triennial reviews
- i1/ Statewide values are based on 5 CCR 1002-8, Section 3 1 11 (Last update 18 CR 2, Effective 2/95) All surface waters of the State are subject to these Statewide standards, unless alternative site-specific standards have been adopted In addition, 5 CCR 1002-8, Section 3 1 16 provides numeric levels that should be considered and applied by the WQCC in establishing site-specific numeric standards Since the Colorado WQCC have adopted site-specific standards (see 5 CCR 1002-8, Section 3 2 8), the Statewide standards (Section 3 1 11) and the Tables contained in Section 3 1 16 do not apply and were not considered as potential ARARs/TBCs For the purpose of implementing CERCLA, the selection of a remedial action and a point of compliance, that are more or less stringent than would be achieved by compliance with a Statewide or site-specific standard is not precluded
- i2/ Statewide standards for AEA regulated radionuclides are not considered to be ARARs because they do not meet the general applicability/promulgated and/or enforceability criteria These shaded Statewide values are listed in table for completeness and will be considered as TBCs where pertinent
- i3/ All standards are chronic or 30-day standards which are based on information contained in EPA's IRIS and/or EPA lifetime health advisories for drinking water using a 10⁻⁶ incremental risk factor unless otherwise noted Shaded values indicate that a site-specific organic standard has been adopted pursuant to 5 CCR 1002-8, Section 3 2 8

EXPLANATION OF TABLE AND ENDNOTES

- i4/ Standards are applicable only to segments classified for water supply Per 5 CCR 1002-8, Section 3 1 13, drinking water supply classification is defined as surface waters that are suitable or intended to become suitable for potable water supplies These surface waters will meet Colorado drinking water regulations after receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration, and disinfection with chlorine or equivalent)
- i5/ Standards are applicable to all Class 1 or 2 aquatic life segments These Class 2 segments will generally be those where fish of a catchable size and which are normally consumed are present, and where there is evidence that fishing takes place on a recurring basis The WQCC may also consider additional evidence that may be relevant to a determination whether the conditions applicable to a particular segment are similar enough to the assumptions underlying the water plus fish ingestion criteria to warrant the adoption of water plus fish ingestion standards for the segment in question
- i6/ Standards are applicable to all aquatic life segments
- j1/ Site-specific values are based on 5 CCR 1002-8, Section 3 8 (Last update 17 CR 6, Effective 6/94)
- j2/ Segment 4 consists of the mainstream and all tributaries of Woman and Walnut Creeks from sources to Standley Lake and Great Western Reservoir except for specific listings in Segment 5 Segment 5 consists of the mainstream of North and South Walnut Creeks, including all tributaries, lakes and reservoirs, from their sources to the outlets of Ponds A-4 and B-5 and Pond C-2 on Woman Creek The site-specific standards apply in lieu of the Statewide standards listed in Section 3 1 11 Where a site-specific standard is not listed, the Statewide standard shall apply Table E-1 has been shaded to indicate when a Statewide standard has been superseded by a site-specific standard [NOTE Site-specific standards for organics are based on water plus fish ingestion These standards apply to all aquatic life class 1 segments and apply to aquatic life class 2 segments on a case-by-case basis]
- j3/ Standard is given as a chronic or 30-day standard

EXPLANATION OF TABLE AND ENDNOTES

j4/ Standard is dependent on hardness as identified below

Cadmium (acute)	$e^{(1.128[\ln(\text{hardness})]-2.905)}$
Cadmium (chronic)	$e^{(0.7852[\ln(\text{hardness})]-3.490)}$
Silver (acute)	$e^{(1.72[\ln(\text{hardness})]-7.21)}$
Silver (chronic)	$e^{(1.72[\ln(\text{hardness})]-9.06)}$
Zinc (acute)	$e^{(0.8473[\ln(\text{hardness})]+0.8604)}$
Zinc (chronic)	$e^{(0.8473[\ln(\text{hardness})]+0.7614)}$

[NOTE Some of the above TVS equations are not consistent with current Federal AWQC]

j5/ Standard is given as a acute standard

j6/ Standard is for Woman Creek

j7/ Standard is for Walnut Creek

j8/ Standard is a temporary modification which applies until April 1, 1996

j9/ Standards for radionuclides in Segment 5 have the temporary modification of ambient quality until December 31, 1996. The value provided is from Table 2 of 5 CCR 1002-8, Section 3 2 8, which indicates that these values are ambient based site-specific standards

k1/ Per 5 CCR 1002-8, Section 3 1 11, all surface waters of the State are subject to Statewide or site-specific standards, however, the discharge of substances regulated by permits which are within those permit limitations shall not be a basis for enforcement. The requirements for integrating Statewide or site-specific standards into discharge permits are identified in 5 CCR 1002-8, Section 3 1 14. For constituents which are regulated by the NPDES permit, the NPDES were considered to be pertinent remediation targets for surface waters

k2/ The discharge from Pond B-3 is restricted to only when weather conditions result in the flow into Pond B-3 which is greater than can be handled by temporary storage in Pond B-3 and spray irrigation. Unless otherwise authorized, the discharge shall consist only of the effluent from the sewerage treatment plant, surface water runoff from the drainage area above Pond B-3, product water (i.e., effluent from the sewerage treatment plant and/or intercepted groundwater from the seepage area near the solar evaporation ponds) from the Reverse Osmosis Plant (Building 910), and intercepted groundwater from the seepage area near the solar evaporation ponds

EXPLANATION OF TABLE AND ENDNOTES

- k3/ Unless otherwise authorized, the discharge from Pond A-3 shall consist only of runoff due to precipitation, seepage from the area of the plant solar evaporation ponds, and intercepted groundwater from the seepage area near the solar evaporation ponds
- k4/ Unless otherwise authorized, the discharge from Ponds A-4 and B-5 is restricted to precipitation events that result in surface runoff into these ponds. Discharge may only occur at least 24 hours following the precipitation event or when the volume of water in the pond reaches approximately 10 percent of the storage capacity of the pond. This discharge restriction does not apply to water that passes through the sand filter collection system or the flow of water over the emergency spillway
- k5/ Limit is based on the average of sample results over a 30-day period
- k6/ Limit is based on the average of sample results over a 7-day period
- k7/ Limit is based on a daily maximum
- k8/ Limit is based on total chromium
- m1/ Values are recommended soil action levels for the cleanup of PCB contaminated soils presented in 40 CFR 761, Subpart G which is entitled *PCB Spill Cleanup Policy*. This policy establishes cleanup criteria for spills that occurred after May 4, 1987 and is classified as a TBC. The action levels for total PCBs are as follows
- | | |
|------------------------------------|--------|
| Residential | 1 ppm |
| Industrial - Non-Restricted Access | 10 ppm |
| Industrial - Restricted Access | 25 ppm |

APPENDIX F
CDPHE CONSERVATIVE SCREEN RESULTS

TABLE F-1
CDPHE CONSERVATIVE SCREEN RESULTS

Source Areas	Medium	Carcinogenic Ratio Sum ^{a/}	Noncarcinogenic Ratio Sum ^{a/}	Recommendations
IHSS 141 Sludge Dispersal	Soil 0-12'	3 8E+00	1 0E-01	
	Groundwater Area 3	3 1E+04	2 4E+01	
IHSS 142 1 A-1 Pond	Sediment	2 8E+01	3 2E-02	No Further Action ^{d/}
	Surface Water	3 7E-03	2 3E-04	
	Groundwater Area 2	1 2E+03	5 3E+01	
IHSS 142 2 A-2 Pond	Sediment	1 2E+01	4 4E-02	No Further Action ^{d/}
	Surface Water	3 7E-03	2 3E-04	
	Groundwater Area 2	1 2E+03	5 3E+01	
IHSS 142 3 A-3 Pond	Sediment	3 2E+00	3 5E-02	No Further Action ^{d/}
	Surface Water	3 7E-03	2 3E-04	
	Groundwater Area 2	1 2E+03	5 3E+01	
IHSS 142 4 A-4 Pond	Sediment	1 7E-01	4 1E-01	No Further Action ^{c/}
	Surface Water	3 7E-03	2 3E-04	No Further Action ^{d/}
	Groundwater Area 2	1 2E+03	5 3E+01	Not a Source Area
IHSS 142 5 B-1 Pond	Sediment	3 4E+02	8 0E-01	No Further Action ^{d/}
	Surface Water	1 8E-02	7 8E-05	
	Groundwater Area 3	3 1E+04	2 4E+01	
IHSS 142 6 B-2 Pond	Sediment	1 1E+02	5 0E-01	No Further Action ^{d/}
	Surface Water	1 8E-02	7 8E-05	
	Groundwater Area 3	3 1E+04	2 4E+01	

TABLE F-1 (continued)
CDPHE CONSERVATIVE SCREEN RESULTS

Source Areas	Medium	Carcinogenic Ratio Sum ^{a/}	Noncarcinogenic Ratio Sum ^{a/}	Recommendations
IHSS 142 7 B-3 Pond	Sediment	1 3E+02	1 0E+00	No Further Action ^{d/}
	Surface Water	1 8E-02	7 8E-05	
	Groundwater Area 3	3 1E+04	2 4E+01	
IHSS 142 8 B-4 Pond	Sediment	3 4E+01	1 4E-01	No Further Action ^{d/}
	Surface Water	1 8E-02	7 8E-05	
	Groundwater Area 3	3 1E+04	2 4E+01	
IHSS 142 9 B-5 Pond	Sediment	2 6E-01	2 5E-03	No Further Action ^{c/}
	Surface Water	1 8E-02	7 8E-05	No Further Action ^{d/}
	Groundwater Area 3	3 1E+04	2 4E+01	Not a Source Area
IHSS 142 12 Walnut & Indiana Pond	Sediment	3 1E-03	3 4E-05	No Further Action ^{c/}
	Surface Water	---	5 0E-05	No Further Action ^{d/}
	Groundwater Area 5	6 5E+02	3 4E+01	Not a Source Area
IHSS 143 Old Outfall	Soil 0-12'	4 7E+01	1 4E-01	No Further Action for all media in this IHSS under OU6 ^{b/}
	Groundwater Area 6	1 8E+03	9 4E+01	
IHSS 156 2 Soil Dump Area	Soil 0-12'	1 6E+00	4 8E-01	
IHSS 165 Triangle Area	Soil 0-12'	1 4E+01	1 1E-01	
	Groundwater Area 4	1 2E+01	4 8E+00	
IHSSs 166 1, 166 2, and 166 3 Trenches A, B, and C	Soil 0-12'	8 3E-01	1 6E-01	No Further Action ^{c/}
	Groundwater Area 1	2 0E+03	7 4E+01	No Further Action Under OU6 ^{b/} , Not a Source Area
IHSS 167 1 North Area Spray Field	Soil 0-12'	4 9E+00	5 5E-02	

TABLE F-1 (continued)
CDPHE CONSERVATIVE SCREEN RESULTS

Source Areas	Medium	Carcinogenic Ratio Sum ^{a/}	Noncarcinogenic Ratio Sum ^{a/}	Recommendations
F167 3 Former South Area Spray Field	Soil 0-12'	1 1E-01	3 8E-03	No Further Action ³ No Further Action ³
	Groundwater Area 1	2 0E+03	7 4E+01	No Further Action Under OU6 ^{b/} , Not a Source Area
IHSS 216 1 East Spray Field	Soil 0-12'	3 5E-01	4 4E-02	No Further Action ^{c/}
Stream Sediment	North Walnut	1 4E+00	7 3E-01	
	South Walnut	6 9E+00	2 3E-04	
	Upgradient	2 8E+00	8 2E-05	
	Walnut & Indiana	3 7E-03	3 3E-05	
Dry Sediment	North Walnut	5 3E+00	1 3E-02	No Further Action ^{c/}
	South Walnut	6 9E+00	9 0E-03	

NOTES

^{a/} For the CDPHE Conservative Screen

Carcinogenic Ratio Sum > 1 is equivalent to > 10⁻⁶ cancer risk level

Carcinogenic Ratio Sum > 100 is equivalent to > 10⁻⁴ cancer risk level

Noncarcinogenic Ratio Sum > 1 is equivalent to Hazard Index > 1

(All assuming long-term residential exposure to maximum detected concentrations of chemicals)

^{b/} No Further Action is recommended based on transfer of administrative responsibility to another operable unit

^{c/} No Further Action is recommended based on risk ratios below one

^{d/} No Further Action is recommended based on risk ratios below one Continued monitoring may be required

APPENDIX G
REMEDIATION TARGET SCREEN RESULTS

TABLE G-1
REMEDIATION TARGET SCREEN RESULTS FOR SURFACE SOIL

Surface Soil Chemical of Concern (Units as Indicated)	Selected Remediation Target ^{a/}	Sludge Dispersal Area	Old Outfall	Soil Dump Area	Triangle Area	North Area Spray Field	Former South Area Spray Field	East Area Spray Field ^{b/}
Antimony (mg/kg)	818	18 7	--	43 6	27 4	IHSS 167 1	F167 3	IHSS 216.1
Silver (mg/kg)	10,200	52 7 ^{c/}	--	--	--	--	--	--
Vanadium (mg/kg)	14,300	75 9	45 5	65 1	34 8	40 1	33 9	42 4
Zinc (mg/kg)	613,000	650	85 4	72 3	117	60 2	119	63 9
Americium-241 (pCi/g)	852	1 84	--	0 30	3 24	1 15	0 064	0 19
Plutonium-239/240 (pCi/g)	1,800	10 4	0 52	1 85	15 20	1 85	0 29	0 76

NOTES

^{a/} Selected remediation targets are presented in Table 4-2

^{b/} Shading of header area indicates that IHSS does not pose a significant risk to human health based on CDPHE Conservative Screen results

^{c/} Shading of table cells indicates that maximum COC concentration for the IHSS are less than the selected remediation target

TABLE G-2
REMEDIATION TARGET SCREEN RESULTS FOR SUBSURFACE SOIL

Subsurface Soil Chemical of Concern (Units as Indicated)	Selected Remediation Target ^{a/}	Old Outfall	Soil Dump Area	Triangle Area	Trench A	Trench B	Trench C	North Area Spray Field	Former South Area Spray Field	East Area Spray Field ^{b/}
Barium (mg/kg)	124,000	1,150 ^{c/}	864	1,050	551	708	2,970	866	182	783
Benzo(a)pyrene (µg/kg)	17,000	170	--	130	--	--	--	--	--	--
Benzo(b)fluoranthene (µg/kg)	170,000	210	--	170	--	--	--	--	--	--
Methylene Chloride (µg/kg)	16,600,000	13	3,600	34	8	3,700	30	--	5	3,750
Americium-241 (pCi/g)	795	0 04	0 31	0 44	01	0 02	0 02	0 03	0 03	0 03
Plutonium-239/240 (pCi/g)	1,570	0 26	0 88	0 53	0 03	01	0 09	0 07	0 10	0 21
Uranium-233/234 (pCi/g)	49,300	1 84	1 3	1 3	1 1	1 12	1 02	3 05	1 04	1 2
Uranium-238 (pCi/g)	3,930	1 52	1 4	1 6	1 2	1 1	1 13	141	97	96

NOTES

^{a/} Selected remediation targets are presented in Table 4-3

^{b/} Shading of header area indicates that IHSS does not pose a significant risk to human health based on CDPHE Conservative Screen results

^{c/} Shading of table cells indicates that maximum COC concentration for the IHSS are less than the selected remediation target

TABLE G-3
REMEDIATION TARGET SCREEN RESULTS FOR POND SEDIMENT

Pond Sediment Chemical of Concern (Units as Indicated)	Selected Remediation Target ^{a/}	Pond A-1	Pond A-2	Pond A-3	Pond A-4	Pond B-1	Pond B-2	Pond B-3	Pond B-4	Pond B-5	Walnut & Indiana Pond
Antimony (mg/kg)	29,200	30 4	--	26	41 4	--	--	68 5	25 6	--	--
Aroclor-1254 (µg/kg)	10,000	590 ^{b/}	590	--	--	10,000	6,600	2,900	1,100	--	--
Benzo(a)pyrene (µg/kg)	23,300	310	75	240	--	870	130	260	570	--	--
Benzo(b)fluoranthene (µg/kg)	233,000	420	--	370	--	3,100	--	770	1,500	--	--
Bis(2-ethylhexyl)phthalate (µg/kg)	12,200,000	485	7,800	990	950	88,000	9,000	9,100	5,000	1,100	130
Silver (mg/kg)	365,000	3 9	--	--	--	345	207	240	102	--	--
Vanadium (mg/kg)	511,000	36 8	32	62 7	57 7	33 1	25 3	32 7	46 2	47 8	36 4
Zinc (mg/kg)	1,000,000	110	409	155	169	1,270	140	346	319	174	74 1
Americium-241 (pCi/g)	1,600	13 2	1 74	66	14	389	23 1	63	7 45	31	05
Plutonium-239/240 (pCi/g)	31,500	36 2	5 65	2 05	29	92	41 2	180	24 1	44	11

205

NOTES

^{a/} Selected remediation targets are presented in Table 4-4

^{b/} Shading of table cells indicates that maximum COC concentration for the IHSS are less than the selected remediation target

TABLE G-4
REMEDIATION TARGET SCREEN RESULTS FOR STREAM SEDIMENT

Stream Sediment Chemical of Concern (Units as Indicated)	Selected Remediation Target ^{a/}	Stream Sediment
Benzo(a)anthracene (μg/kg)	233,000	430 ^{b/}
Benzo(a)pyrene (μg/kg)	23,300	480
Benzo(b)fluoranthene (μg/kg)	233,000	650
Cobalt (mg/kg)	1,000,000	12 4
Indeno(1,2,3-cd)pyrene (μg/kg)	233,000	180
Strontium (mg/kg)	1,000,000	95 8
Vanadium (mg/kg)	511,000	33 9
Zinc (mg/kg)	1,000,000	178
Americium-241 (pCi/g)	1,600	0 75
Plutonium-239/240 (pCi/g)	31,500	0 68

NOTES

^{a/} Selected remediation targets are presented in Table 4-5

^{b/} Shading of table cells indicates that maximum COC concentration are less than the selected remediation target

TABLE G-5
REMEDIATION TARGET SCREEN RESULTS FOR GROUNDWATER

Groundwater Chemical of Concern (Units as Indicated)	Selected Remediation Target ^{a/}	Groundwater Area 1 ^{b/}	Groundwater Area 2 ^{c/}	Groundwater Area 3 ^{d/}	Groundwater Area 4 ^{e/}	Groundwater Area 5 ^{f/}	Groundwater Area 6 ^{g/}
Chloroform (μg/l)	100	8 ^{b/}	0 20	--	1 0	--	3
Methylene Chloride (μg/l)	5	32	2	14	0 2	10	0 6
Nitrate (mg/l)	10	--	596	--	--	--	--
Tetrachloroethene (μg/l)	5	13	2	2 2	3	--	0 2
Trichloroethene (μg/l)	5	150	2	6	4	--	0 1
Vinyl Chloride (μg/l)	2	--	--	860	--	--	--
Americium-241 (pCi/l)	30	0 06	1 09	0 02	01	3 2	0 04
Plutonium-239/240 (pCi/l)	30	02	3 65	0 01	007	2 2	0 007
Radium-226 (pCi/l)	100	36	0 72	--	1 2	1 1	8 8

NOTES

- ^{a/} Selected remediation targets are presented in Table 4-6
- ^{b/} Associated IHSSs include 166 1, 166 2, 166 3, and 167 1 Also includes F167 3
- ^{c/} Associated IHSSs include 142 1, 142 2, 142 3, and 142 4
- ^{d/} Associated IHSSs include 141, 142 5, 142 6, 142 7, 142 8, and 142 9
- ^{e/} Associated with IHSSs 156 2 and 165
- ^{f/} Associated with IHSS 142 12
- ^{g/} Associated with IHSS 143
- ^{h/} Shading of table cells indicates that maximum COC concentration for the Groundwater Area are less than the selected remediation target

TABLE G-6
REMEDATION TARGET SCREEN RESULTS FOR SURFACE WATER

Surface Water Chemical of Concern (Units as Indicated)	Selected Remediation Target ^{a/}	Pond A-1 ^{b/}	Pond A-2 ^{b/}	Pond A-3 ^{b/}	Pond A-4 ^{b/}	Pond B-1 ^{b/}	Pond B-2 ^{b/}	Pond B-3 ^{b/}	Pond B-4 ^{b/}	Pond B-5 ^{b/}	Walnut & Indiana Pond ^{b/}
		IHSS 142.1	IHSS 142.2	IHSS 142.3	IHSS 142.4	IHSS 142.5	IHSS 142.6	IHSS 142.7	IHSS 142.8	IHSS 142.9	IHSS 142.12
Acetone (µg/l)	3,650	--	--	--	--	50 ^{c/}	18	20	17	11	140
Chloroform (µg/l)	6	--	--	--	--	--	--	1	2	2	--
1,2-Dichloroethene (µg/l)	7	--	--	--	--	--	3	--	--	--	--
Methylene Chloride (µg/l)	5	--	--	--	--	--	--	36	34	--	--
Trichloroethene (µg/l)	5	--	--	--	--	--	4	--	6	--	--

NOTES

^{a/} Selected remediation targets are presented in Table 4-7

^{b/} Shading of header area indicates that IHSS does not pose a significant risk to human health based on CDPHE Conservative Screen results

^{c/} Shading of table cells indicates that maximum COC concentration for the IHSS are less than the selected remediation target

TABLE 4-2
PRELIMINARY REMEDIATION LEVELS FOR SURFACE SOIL

Surface Soil Chemical of Concern (Units as Indicated)	Background Concentration (UTL _{max})	Minimum Analytical Detection Limit	Potential Chemical-Specific ARARs/TBCs		Programmatic Risk Based PRG												Cleanup Standards Established at Other Colorado NPL Sites	Selected Remediation Target
					Residential				Commercial/Industrial ^v				Ecological Researcher					
			RME ^w		CT ^y		RME ^w		CT ^y		RME ^w		CT ^y					
			NC ^u	C ^u	NC ^u	C ^u	NC ^u	C ^u	NC ^u	C ^u	NC ^u	C ^u	NC ^u	C				
Antimony (mg/kg)	5 00e+01	1 20e+01	-	-	1 10e+02	-	2 93e+02	-	8 18e+02	-	9 33e+03	-	3 15e+03	-	1 05e+04	-	8 18e+02	
Silver (mg/kg)	1 00e+01	2 00e+00	-	-	1 37e+03	-	3 66e+03	-	1 02e+04	-	1 17e+05	-	3 94e+04	-	1 31e+05	-	1 02e+04	
Vanadium (mg/kg)	5 56e+01	1 00e+01	-	-	1 92e+03	-	5 12e+03	-	1 43e+04	-	1 63e+05	-	5 52e+04	-	1 84e+05	-	1 43e+04	
Zinc (mg/kg)	8 66e+01	4 00e+00	-	-	8 23e+04	-	2 19e+05	-	6 13e+05	-	>1 00e+06	-	>1 00e+06	-	>1 00e+06	-	6 13e+05	
Americium 241 (pCi/g)	6 00e-02	2 00e-02	-	8 52e+02 ^v	-	2 37e+00	-	2 04e+01	-	9 55e+00	-	2 49e+02	-	2 04e+02	-	2 83e+02	8 52e+02	
Plutonium 239/240 (pCi/g)	1 33e-01	3 00e-02	-	1 80e+03 ^v	-	3 42e+00	-	3 20e+01	-	1 38e+01	-	9 47e+02	-	5 28e+02	-	1 71e+03	1 80e+03	

NOTES

- Commercial/Industrial exposure is based on an office worker scenario
- ^w PRGs are based on Reasonable Maximum Exposure factors
 - ^u PRGs are based on Central Tendency Exposure factors
 - ^y PRGs are based on non-carcinogenic toxicity information
 - ^z PRGs are based on carcinogenic toxicity information
 - SOURCE Martin Marietta Denver Aerospace (EPA/ROD/R08-90/035) Cleanup standard is provided as mg/L and is based on a LDR treatment standard which is applied to the TCLP extract from the treated waste
 - ^v SOURCE Woodbury Chemical (EPA/ROD/R08-89/025) Cleanup standard is based on limiting carcinogenic exposure risk to less than 10⁻⁶ however zinc is not a carcinogen
 - ^w TBC value based on RME exposure factors at a 100 mrem per year effective dose equivalent for the office worker exposure scenario
 - Minimum analytical detection limits originate from the General Radiochemistry and Routine Analytical Services Protocol (EG&G 1991 and EG&G 1991a)

TABLE 4-7
PRELIMINARY REMEDIATION LEVELS FOR SURFACE WATER

Surface Water Chemical of Concern (Units as Indicated)	Background Concentration (UTL ^{uu})	Minimum Analytical Detection Limit ^v	Potential Chemical-Specific ARARs/TBCs		Programmatic Risk Based PRGs ^w												Cleanup Standards Established at Other Colorado NPL Sites	Selected Remediation Target
					Residential Swimming			Ecological Worker Wading			Residential Drinking Water							
					RME ^w		CT ^d		RME ^w		CT ^d		RME ^w		CT ^d			
			ARARs	TBCs	NC ^u	C ^u	NC ^u	C ^u	NC ^u	C ^u	NC ^u	C ^u	NC ^u	C ^u	NC ^u	C ^u		
Acetone (µg/L)	0 00e+00 ^u	1 00e+01	—	—	2 81e+06	—	—	7 30e+06	—	—	3 66e+07	—	3 65e+03	—	5 44e+03	—	3 65e+03	
Chloroform (µg/L)	0 00e+00	5 00e+00	<1 00e+02 ^{u,w}	—	2 81e+05	1 07e+04	5 11e+06	6 52e+05	7 30e+05	3 66e+06	1 68e+03	2 76e-01	3 65e+02	5 45e+02	1 52e+00	5 45e+02	1 00e+02	
1 2 Dichloroethene (µg/L)	0 00e+00 ^u	5 00e+00	7 00e+01 ^{u,w}	—	2 53e+05	—	4 60e+06	—	6 57e+05	—	3 29e+06	—	3 28e+02	—	4 90e+02	—	7 00e+01	
Methylene Chloride (µg/L)	0 00e+00	5 00e+00	5 00e+00 ^{u,w}	—	1 68e+06	8 73e+03	3 07e+07	5 30e+05	4 38e+06	2 73e+05	2 20e+07	1 36e+06	1 73e+03	6 22e+00	2 64e+03	3 23e+01	5 00e+00	
Trichloroethene (µg/L)	0 00e+00 ^u	5 00e+00	5 00e+00 ^{u,w}	—	—	5 95e+03	—	3 61e+05	—	1 86e+05	—	9 29e+05	—	2 55e+00	—	1 36e+01	5 00e+00	

NOTES

- ^v PRGs are based on residential and ecological researcher exposure scenarios for wading/swimming
- ^w PRGs are based on Reasonable Maximum Exposure factors
- ^u PRGs are based on Central Tendency Exposure factors
- ^u PPGs are based on non-carcinogenic toxicity information
- ^u PRGs are based on carcinogenic toxicity information
- ^u Background concentrations for organic compounds are assumed to be zero
- ^u ARAR standard is based on Colorado Statewide Standard for Surface Water (SCCR 1002 8 Section 3 1 11) for drinking water supply classification All organic values are interim standards
- ^u ARAR standard is based on Maximum Contaminant Levels (40 CFR 141 and 142) Value for chloroform is based on the sum of all trihalomethanes (i e bromodichloromethane dibromochloromethane bromoform and chloroform) Value for 1 2-dichloroethene is based on the cis-isomer since its MCL is lower than the trans-isomer
- Minimum analytical detection limits originate from the General Radiochemistry and Routine Analytical Services Protocol (EG&G 1991 and EG&G 1991a)